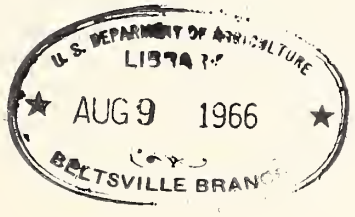
PROXIMATE COMPOSITION OF BEEF FROM CARCASS TO COOKED MEAT: Method of Derivation and Tables of Values



Home Economics Research Report No. 31

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

FOREWORD

Beef is an important item in the American diet, and data on the chemical and physical composition of beef are essential for many purposes. The data are needed for making nutritional evaluations of food supplies, diets of groups, and diets of individuals; for developing nutritionally adequate food plans at different cost levels; for planning special therapeutic diets; for estimating yields of lean and fat from different cuts or parts of the carcass; and for conducting many kinds of research in nutrition and food science.

This bulletin presents average values based on data currently available for the physical and proximate composition of beef carcasses of U.S. grades: Prime, Choice, Good, Standard, Commercial, and Utility. Values are also presented for untrimmed retail cuts and for trimmed retail cuts with specified proportions of lean from each of the three principal grades—Choice, Good, and Standard. Data are provided also for the composition of separable lean and separable fat for each of the retail cuts from these three grades. In addition, values are presented for these retail cuts of meat and for their separable lean portion after the meat is cooked.

The values for separable lean and separable fat bear the appropriate relationships to the composition of the carcass and the cuts. With these values, it is possible to calculate data on the composition of cuts of beef with any other proportions of separable lean, separable fat, and bone. Changes in production and marketing practices might require such calculations.

The method of deriving the values from carcasses of different grades through the stages of cutting into retail cuts, of trimming, and of cooking is described in detail in this bulletin. This method was developed especially for use in preparing values for meat for "Composition of Foods—raw, processed, prepared," Agriculture Handbook No. 8, Revised (1963). Certain of the data for beef items were selected for inclusion in that Handbook.

The beef values derived as explained in this bulletin rest on a broader and more reliable basis than did values previously compiled. However, as will become apparent in the study of the method presented here, additional research is needed to fill current gaps and to strengthen the basis of present values at various steps in deriving the figures for the average composition of beef.

WASHINGTON, D.C. ISSUED DECEMBER 1965

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 Price 25 cents

CONTENTS

TABLES

FIGURES

PROXIMATE COMPOSITION OF BEEF FROM CARCASS TO COOKED MEAT:

Method of Derivation and Tables of Values

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INTRODUCTION

The composition of meat is a major problem in dietary calculations because of the wide differences in fat content that occur in meats available to the consumer. Because of this wide variance, "average" values for meat have less validity than have "average" values for many other foods.

This publication deals with three important causes of differences in the physical and proximate composition of beef. The first is the natural variation from carcass to carcass, depending largely on the amount of fat laid down by the animal and the distribution of fat in different parts of the body. Secondly, the trimming of individual cuts for the market may significantly alter the natural relationship of lean, fat, and bone. The third factor considered is the effect of cooking on the physical components and proximate nutrients of the meat.

The edible portion of meat includes the lean or muscular part and the fat tissue combined in varying proportions in different parts of the animal. Each portion differs greatly in composition; the lean is high in protein and low in chemical fat (ether extract), whereas the fat tissue is low in protein and high in chemical fat. Therefore, the proportions in which these tissues are combined determine to a large extent the composition of a particular cut of meat. The lean and the fat portions vary also in composition from one animal to another and in different parts of the body, but these variations are of smaller magnitude than those between the kinds of tissues.

Meat undergoes considerable manipulation, involving trimming of fat at different stages of marketing and preparation—at the wholesale level, the retail outlet, the kitchen, and the table. Any or all of these may affect the composition of meat. The cutting of a carcass or wholesale cuts into retail cuts is not standardized throughout the country, and the different methods of separation may result in different amounts of fat on retail cuts made from similar wholesale cuts.

A small amount of fat and bone is trimmed when a carcass is cut into wholesale cuts. Additional trimming is done in separating the wholesale cuts into retail cuts, and this may be extensive or slight, depending on such factors as the finish of the carcass, the price of meat, and the demands of individual consumers. The consumer also may remove some or all remaining fat in the kitchen or at the table. Methods of cooking the meat introduce other variables affecting its composition. Thus the final product ready for consumption may bear little resemblance to the cut as it was taken from the carcass. Various attempts have been made in the past to present data for the different stages of preparation.

U.S. Department of Agriculture publications on food composition evolve from the first American tables prepared by W. O. Atwater and C. D. Woods, Office of Experiment Stations Bulletin No. 28, in 1896 (*1*).[1] In that bulletin, data for meats were averaged, from available studies, by cut and relative fatness.

In 1926, Department Circular 389, "Proximate Composition of Beef," (*4*) was issued. That publication related composition of the carcass by relative fatness to meat grades then in effect. Wholesale cuts, in turn, were related to the composition of the carcass. For each individual cut, the correlation between fat in the cut and fat in the carcass was high. The regressions for different cuts, however, were at different levels and had different slopes. It was therefore necessary to develop a number of curves to express the relationship of fat content of the cuts to fat content of the carcass.

The estimates of protein, ash, and water within a cut were based on their relationships to the specific chemical fat content of the cut; it had been shown

[1] Italic numbers in parentheses refer to Sources of Data, p. 32.

previously (*18, 25*) that these nutrients, when expressed on a fat-free basis, occur in a relatively constant proportion in the mature animal regardless of fatness or age.

The techniques developed in Department Circular 389 (*4*) for deriving the composition of meat provided a basis that was far superior to straight averages of similar cuts; the straight-average method did not take into account the variations from animal to animal. The composition, both physical and chemical, of all wholesale cuts was directly related to the composition of the carcass from which the cuts were taken.

Data on retail cuts were not developed in detail in Department Circular 389 (*4*) because of too few analyses, but a method was proposed, based on very limited data, whereby the fat content of the wholesale cut was related to the fat in the trimmed retail cut.

The values for wholesale cuts were used in Circular 549, "Proximate Composition of American Food Materials," published in 1940 (*6*), and served as the standard values for dietary calculations until they were superseded by later revisions of the tables. For many purposes, these data overestimated the fat content and the calories yielded, because there was no basis for adjusting them for trimming that occurred after the wholesale level. It became necessary, therefore, to attempt to correct these overestimates and to approach the retail level of fat trimming.

In the 1950 edition of Agriculture Handbook No. 8, "Composition of Foods—raw, processed, prepared" (*29*), the data for meat cuts were adjusted to allow for a moderate amount of trimming. The values still included a large margin of error when used to apply to meats that deviated markedly in fat content, both above and below the averages.

Cooked meats have also been the subject of study in the U.S. Department of Agriculture. Many analyses of cooked meats, described as to kind of meat, cut, and cooking method, have appeared in the literature. A classification of cooked meats based on this type of information was made by Chatfield (*5*) in 1937. The results were presented in eight classes representing different fat levels and degrees of doneness; the kind of animal was not a basis for separation. Beef, lamb, pork, veal, and poultry were combined in deriving the average values. This classification had the advantage of great simplicity. However, with only four levels of fat content and eight of protein taken into account, dietary calculations based on these values could embody wide margins of error, especially in fat content and calories.

When the problem was being studied for the 1950 edition of Agriculture Handbook No. 8 (*29*), an effort was made to develop data for cooked meats in relation to the raw cuts from which they were prepared, but the data were insufficient to give satisfactory results. The limited data available indicated a relationship between the composition of the cooked cut and that of the raw cut from which it was prepared, but the extent of this relationship was not apparent at that time.

The entire problem of the composition of meat at different stages of processing has been reexamined in the light of new well-planned studies, with the purpose of revising data on beef in food composition tables, especially Handbook 8, Revised (*30*). The results obtained are the subject of this publication. A method is described that relates the composition of the carcass to the various retail cuts, to the effects of trimming, to the composition of the separable lean and separable fat, and to the effects of cooking. The method presented is sufficiently flexible to permit the derivation of values for cuts that differ significantly in trimming from average data.

COMPOSITION OF THE CARCASS

The carcass represents the stage at which relatively little handling has occurred and very little trimming has been done. The natural variation among animals is the most important variable at this stage. Livestock growers, meat graders, and many other groups are interested in the composition of the carcass. Therefore, there are usually more analyses of the carcass available than of cuts of meat sufficiently alike for summarizing. Because of the relative lack of handling and the greater number of available analyses, the carcass provides the best starting point for establishing average data on the composition of meat.

Grade and cut are two factors the consumer usually knows about the meat purchased, and these are related in some degree to composition. It seemed desirable, therefore, to develop our data on the basis of these factors.

Grades of beef were revised in December 1950; few of the studies on composition made before that date provided sufficient information for adapting data to the new standards. Under the 1950 standards, Prime grade comprised the former Prime and Choice; Choice was the previously named Good. Good grade was applied to the beef from young animals formerly included in the top half of the Commercial grade. Commercial grade was applied to the balance of the old Commercial, but later—in 1956—this grade was divided into two; the younger animals were graded Standard, and the more mature ones remained Commercial. There was no change in Utility grade.

We began collecting data on carcasses graded under the new standards and finally assembled, from published and unpublished sources, chemical analyses of 101 carcasses of beef. Most of the analyses were provided by studies made at the University of Tennessee under J. W. Cole (*8*), at the Illinois Agricultural Experiment Station under Sleeter Bull (*16*), and in U.S. Department of Agriculture, Agricultural Research Service, under Edward W. Toepfer (*28*). The data from Illinois, although

collected before 1950, were reviewed and regraded from original records to conform with the grades in effect after 1950.

For uniformity in analytical methods throughout the present study, samples of entire carcasses analyzed by chemical methods only were used. Other methods of estimating fat in animal carcasses have been proposed. They include analyses of portions of the carcass, such as the 9th-10th-11th ribs as indices of total carcass composition (*15*); determinations of specific gravity related to physical and chemical composition (*17*); fat probes at certain positions on the carcass (*2*); ultrasonic methods of estimating fat (*26*); and the use of a potassium isotope as a measure of muscle mass (*31*). Numerous variations of these procedures have also been investigated. All of them provide rapid, inexpensive, and reasonably accurate methods of estimating the fat content of the carcass. If in the future their use becomes widespread, many more estimates of fat in the carcass may become available.

We have not used fat estimated by these rapid methods because we wished to avoid variables due to methods, and because most of the studies using rapid methods have not included information on grade.

The distribution of the samples is shown in figure 1 by fat content as determined chemically, and by grade. In one study, we had only the average values for each grade; these have been shown at their average weighted by the number of carcasses analyzed. The fat content of the individual carcasses in each grade overlaps that of other grades except for Prime, where we did not have the individual samples to plot. However, average content of fat decreases with grade from Prime to Utility, except for Commercial grade. Commercial grade, atypical of the pattern, includes cows that are fat but are too old to be eligible for a higher grade.

The average fat content of carcasses for the several grades as derived from the above-mentioned samples is shown as follows, rounded to the nearest whole percent:

	Percentage of fat	Number of carcasses
Prime	41	5
Choice	35	26
Good	28	25
Standard	21	32
Commercial	31	9
Utility	18	4

Among these 101 carcasses, there were 72 on which data were provided for protein, water, bone content, and separable fat in addition to chemical fat. The relationship of these components to chemical fat were then studied, and regression equations were derived to express this interdependence. The equations thus developed can be used to estimate the chemical and physical composition of carcasses at any specified content of chemical fat. The results are shown below:

Regressions	Correlation coefficient	Standard error (SE)[1]	Number of samples
Water (%) = 76.07 − 0.73 × fat (%)	−0.97**	1.40	72
Protein (%) = 22.58 − 0.22 × fat (%)	−0.76**	1.33	72
Separable fat (% in edible portion) = 8.00 + 0.92 × fat (%)	0.97**	1.77	72
Bone (% in "as purchased") = 21.53 − 0.19 × fat (%)	−0.65**	1.57	72

[1] Standard error of estimate. **Significant at the 1-percent level.

TABLE 1.—*Physical and chemical composition of beef carcasses by grade*

Grade	As purchased			Edible portion including kidney and kidney fat				
	Separable lean	Separable fat	Bone	Water		Protein	Fat	Ash
				By regression	By difference			
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Prime	47	39	14	46.3	44.8	13.6	41	0.6
Choice	51	34	15	50.6	49.4	14.9	35	.7
Good	56	28	16	55.7	54.7	16.5	28	.8
Standard	60	22	18	60.8	60.1	18.0	21	.9
Commercial	54	31	16	53.6	52.4	15.8	31	.8
Utility	62	20	18	63.0	62.5	18.6	18	.9

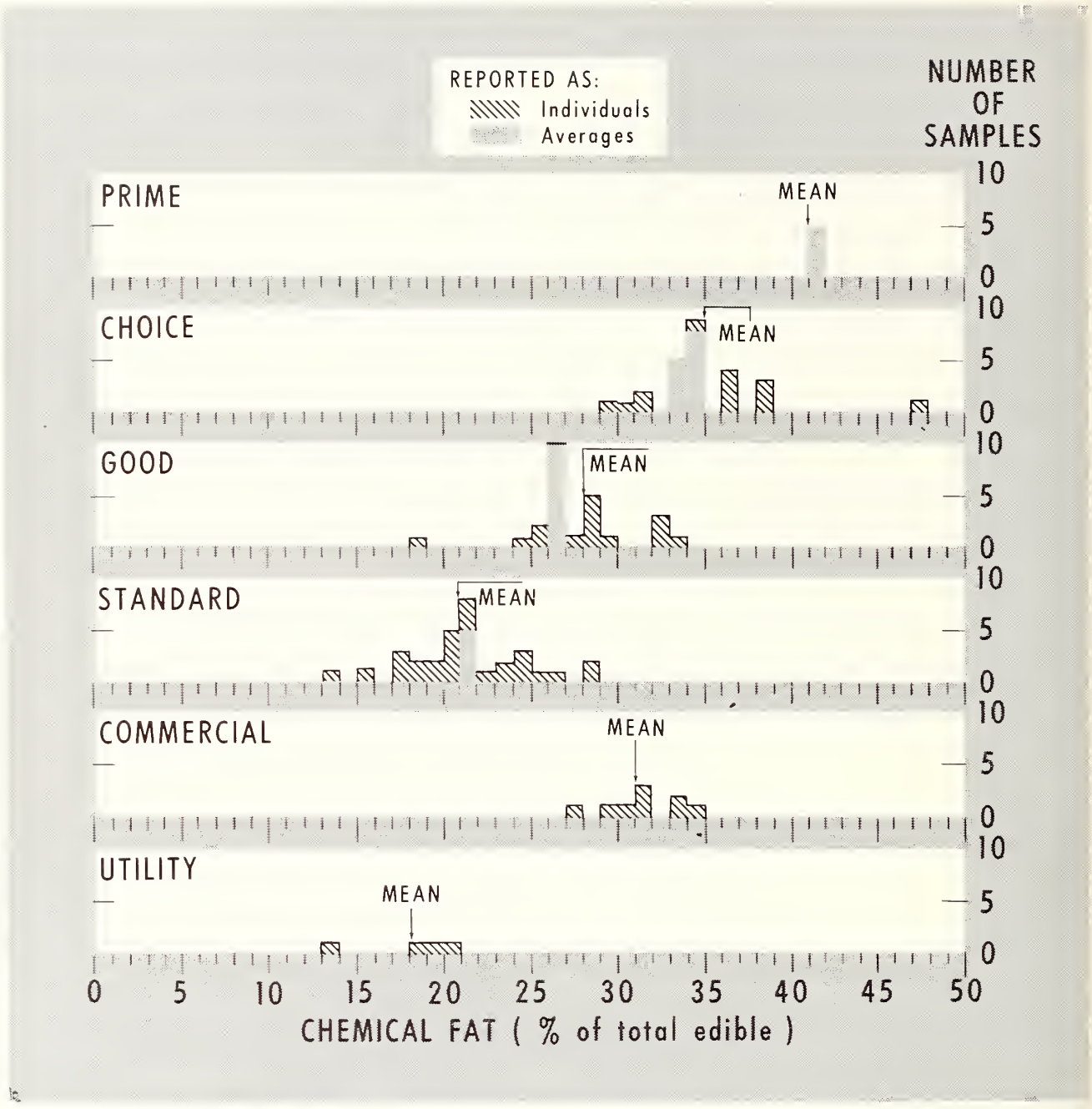

Figure 1.—Beef carcass—by grade and fat content.

With these relationships established, we then calculated the chemical constituents and physical composition of beef carcasses of average fat content for each grade, using the values for percentage of fat shown on page 3 in the above equations. The resulting values for the six grades are given in table 1. Since none of the samples included above was analyzed for ash, values for this nutrient were read from the curve calculated in Department Circular 389 (*4, p. 6*). Water as determined by chemical methods was used in deriving the regression equation. The percentage of water is shown in table 1, calculated by equation and by difference, since in our tables of food composition, we usually report water in meats by difference to account for 100 percent. Chemical analyses of meat rarely add to exactly 100 percent because of inherent errors in methods of determining proximate nutrients. Usually, however, the chemical analyses add to within ±1 percent, and the effect of calculating water by difference is to throw this small error on the water content, where it is relatively unimportant because of the magnitude of the moisture compared with other nutrients.

Separable fat as determined by the equation on p. 3 is in percentage of the edible portion; that is, without bone. Separable fat has been calculated on the "as purchased" basis—that is, with the bone in—for table 1. The percentage of separable fat in the edible portion is multiplied by the percentage of edible portion, and the result is divided by 100 percent. The edible portion is 100 percent minus the percentage of bone.

With bone and separable fat expressed as percentages of the "as purchased," the difference between their sum and 100 percent equals the percentage of lean meat.

The calculation for Prime grade is as follows:

Separable fat (% in edible portion) = 8.00 + 0.92 (41) = 45.7%

Separable fat (% in "as purchased") = 45.7% (fat in edible portion) × 86.3% (edible portion) = 39.4%

Bone (% in "as purchased") = 21.53 − 0.19 (41) = 13.7%

Edible portion = 100% − 13.7% (bone) = 86.3%

Separable lean = 86.3% − 39.4% = 46.9%

The relationship of individual cuts to these same carcasses was studied next.

COMPOSITION OF UNTRIMMED RETAIL CUTS

It was recognized in Department Circular 389 (*4*) that the composition of retail cuts would be related to that of the wholesale cuts, but that the relationships would vary with the amount of trimming. Not enough data were available at that time to develop the idea extensively. However, it was clear that if the composition of retail cuts were related to that of wholesale cuts it must be related to the carcass also. A study in Illinois made possible the use of these relationships.

Results of the study made at the Illinois Agricultural Experiment Station in the 1940's were partly published in Annual Reports (*16*). Unpublished material from this study, made available to us, provided a wealth of material in great detail that could be used in various ways. Twenty-five beef carcasses of four grades were broken down into retail cuts, and the physical and chemical composition of each cut was determined. The location of the retail cuts analyzed is shown in figure 2. These cuts were not trimmed except for small amounts of bone and fat necessarily removed in separating the cuts. The lean meat and the fat tissue were analyzed separately.

The results for individual animals were not available but had been averaged for each of the four grades so we do not know the variation around the means. We had four points from which to construct the necessary curves, and we used the curves directly rather than calculate regression equations on such small numbers.

It was possible, with both physical and chemical composition of the cuts and the proportions in which they occurred in the carcass, to composite the values for the entire carcass. We could then study the relationships of each untrimmed retail cut to the

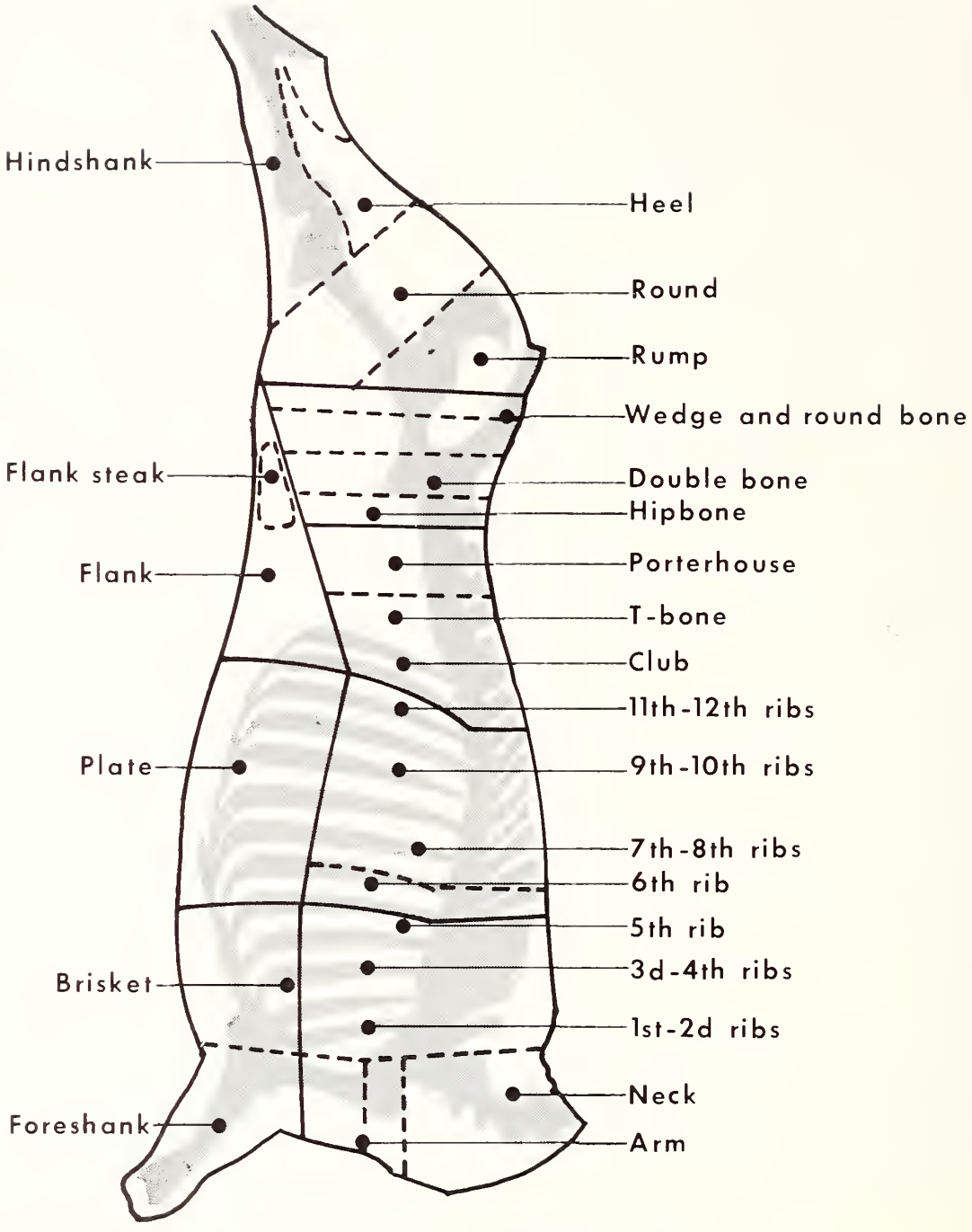

Figure 2.—Location of retail cuts.

carcass by the same method described in Department Circular 389 (*4*), relating the fat content of the retail cuts instead of the wholesale cuts to the fat content of the carcasses.

Figure 3 shows the relation of a few untrimmed retail cuts of widely different fat contents to the fat in the carcass. Most of the other cuts fall between the extremes shown, and overlap with them to such an extent that they cannot be read easily from the same chart. A selection was therefore made here for illustration.

For table 2, we estimated from these curves the fat of each untrimmed cut from carcasses of average composition shown in table 1. This was done for only three grades—Choice, Good, and Standard—reading the curves at 35, 28, and 21 percent fat, respectively. These three grades account for the bulk of federally graded beef sold in the United States (about 94 percent in 1962). The other grades could be read from the curves also, except Utility, which is beyond the limit of observations in fat content.

As an example of the procedure, flank of Choice grade (read at 35 percent carcass fat) contains 55.5 percent chemical fat; Good grade (at 28 percent carcass fat) averages 49.3 percent chemical fat. Standard grade (at 21 percent carcass fat) contains 42.2 percent chemical fat.

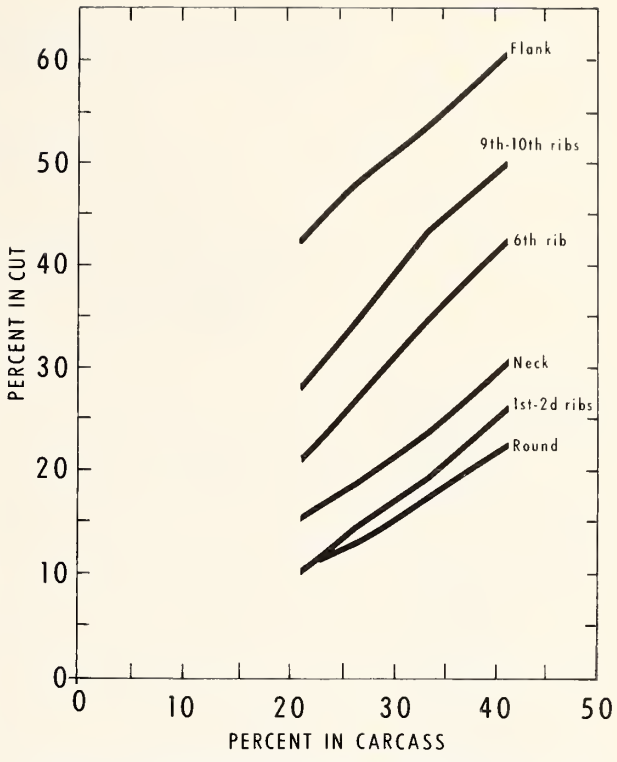

Figure 3.—Chemical fat in edible portion of untrimmed cut and carcass.

TABLE 2.—*Physical and chemical composition of carcasses and raw retail cuts before trimming, and of separable lean and separable fat—three grades*

Description	Physical composition					Chemical composition					
	As purchased			Edible portion		Edible portion					
	Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water		Protein	Fat	Ash	Food energy
						By regression	By difference				
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./100 g.*
Carcass: Total edible including kidney and kidney fat:											
Prime grade	47	39	14	54	46	46.3	44.8	13.6	41.	0.6	428
Choice grade	51	34	15	60	40	50.6	49.4	14.9	35.	.7	379
Good grade	56	28	16	66	34	55.7	54.7	16.5	28.	.8	323
Standard grade	60	22	18	73	27	60.8	60.1	18.0	21.	.9	266
Commercial grade	54	31	16	64	36	53.6	52.4	15.8	31.	.8	347
Utility grade	62	20	18	76	24	63.0	62.5	18.6	18.	.9	242
Retail cuts:											
Brisket:											
Choice grade:											
Total edible	44	44	12	50	50	42.4	42.4	13.5	43.5	.6	450
Separable lean						69.9	69.7	21.1	8.2	1.0	165
Separable fat						15.7	15.3	5.9	78.6	.2	734
Good grade:											
Total edible	48	38	13	56	44	48.3	48.0	15.1	36.2	.7	391
Separable lean						72.0	71.5	21.5	6.0	1.0	146
Separable fat						18.9	18.5	7.3	73.9	.3	698

TABLE 2.—*Physical and chemical composition of carcasses and raw retail cuts before trimming, and of separable lean and separable fat—three grades*—Continued

Description	Physical composition					Chemical composition					
	As purchased			Edible portion		Edible portion					
	Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water		Protein	Fat	Ash	Food energy
						By regression	By difference				
Retail cuts—Continued											
Brisket—Continued	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./100 g.*
Standard grade:											
Total edible	51	34	15	60	40	52.9	52.6	16.3	30.4	0.7	344
Separable lean						73.1	72.5	21.6	4.9	1.0	136
Separable fat						22.3	21.9	8.9	68.9	.3	659
Chuck cuts:											
5th rib:											
Choice grade:											
Total edible	56	30	15	65	35	49.3	49.0	15.4	34.9	.7	281
Separable lean						67.3	67.4	20.7	11.0	.9	188
Separable fat						14.7	14.3	5.5	80.0	.2	745
Good grade:											
Total edible	61	23	16	72	28	55.8	55.4	17.1	26.7	.8	314
Separable lean						70.1	69.8	21.2	8.0	1.0	163
Separable fat						18.2	17.8	7.0	74.9	.3	705
Standard grade:											
Total edible	64	17	19	80	20	62.2	61.5	18.8	18.8	.9	250
Separable lean						71.8	71.4	21.4	6.2	1.0	147
Separable fat						23.0	22.6	9.2	67.9	.3	652
3d–4th ribs:											
Choice grade:											
Total edible	61	26	13	70	30	53.0	52.6	16.3	30.3	.8	343
Separable lean						68.3	68.2	20.9	9.9	1.0	179
Separable fat						15.8	15.4	6.0	78.4	.2	733
Good grade:											
Total edible	64	22	14	75	25	58.6	58.1	17.9	23.2	.8	286
Separable lean						71.4	70.9	21.4	6.7	1.0	151
Separable fat						19.8	19.4	7.8	72.5	.3	687
Standard grade:											
Total edible	67	16	17	81	19	63.7	63.0	19.2	16.9	.9	234
Separable lean						72.6	72.0	21.6	5.4	1.0	141
Separable fat						24.3	24.0	9.8	65.9	.3	636
1st–2d ribs:											
Choice grade:											
Total edible	71	15	14	83	17	61.0	60.4	18.5	20.2	.9	261
Separable lean						69.6	69.3	21.1	8.6	1.0	168
Separable fat						17.9	17.6	6.9	75.3	.2	709
Good grade:											
Total edible	73	13	14	85	15	64.9	64.2	19.5	15.4	.9	222
Separable lean						71.7	71.3	21.4	6.3	1.0	148
Separable fat						23.5	23.1	9.4	67.2	.3	646
Standard grade:											
Total edible	75	9	16	89	11	68 9	68.1	20.6	10.4	.9	182
Separable lean						73.4	72.8	21.7	4.5	1.0	133
Separable fat						28.3	28.0	11.5	60.1	.4	591
Arm:											
Choice grade:											
Total edible	63	28	9	69	31	55.0	54.5	16.9	27.8	.8	323
Separable lean						72.6	72.0	21.6	5.4	1.0	141
Separable fat						15.6	15.2	5.8	78.8	.2	736
Good grade:											
Total edible	66	24	10	74	26	59.1	58.6	18.0	22.6	.8	281
Separable lean						73.9	73.2	21.8	4.0	1.0	129
Separable fat						18.3	17.9	7.1	74.7	.3	704
Standard grade:											
Total edible	69	21	10	77	23	62.6	62.1	18.9	18.2	.8	245
Separable lean						74.9	74.1	21.9	3.0	1.0	121
Separable fat						22.2	21.9	8.8	69.0	.3	660

TABLE 2.—*Physical and chemical composition of carcasses and raw retail cuts before trimming, and of separable lean and separable fat—three grades*—Continued

Description	Physical composition					Chemical composition					
	As purchased			Edible portion		Edible portion					
	Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water		Protein	Fat	Ash	Food energy
						By regression	By difference				
Retail cuts—Continued											
Chuck cuts—Continued											
Neck:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./ 100 g.*
Choice grade:											
Total edible	59	24	17	71	29	57.5	57.0	17.6	24.6	0.8	297
Separable lean						72.3	71.8	21.5	5.7	1.0	143
Separable fat						20.3	19.9	8.0	71.8	.3	682
Good grade:											
Total edible	62	20	18	75	25	61.5	61.0	18.6	19.6	.8	256
Separable lean						73.4	72.8	21.7	4.5	1.0	133
Separable fat						24.1	23.7	9.7	66.3	.3	639
Standard grade:											
Total edible	62	16	21	79	21	64.9	64.2	19.5	15.4	.9	222
Separable lean						73.8	73.2	21.7	4.1	1.0	130
Separable fat						29.4	29.1	12.0	58.5	.4	579
Flank:											
Choice grade:											
Total edible	32	68	0	32	68	32.8	33.1	10.9	55.5	.5	547
Separable lean						72.6	71.7	21.6	5.7	1.0	144
Separable fat						15.7	15.3	5.9	78.6	.2	734
Good grade:											
Total edible	36	64	0	36	64	37.8	37.9	12.2	49.3	.6	497
Separable lean						73.1	72.1	21.8	5.1	1.0	139
Separable fat						18.8	18.4	7.3	74.0	.3	699
Standard grade:											
Total edible	41	59	0	41	59	43.5	43.4	13.8	42.2	.6	440
Separable lean						73.8	72.9	21.9	4.2	1.0	131
Separable fat						22.5	22.2	8.9	68.6	.3	657
Foreshank:											
Choice grade:											
Total edible	45	14	41	76	24	63.0	62.4	19.0	17.7	.9	241
Separable lean						73.4	72.8	21.7	4.5	1.0	133
Separable fat						27.7	27.3	11.3	61.0	.4	598
Good grade:											
Total edible	46	12	42	79	21	66.5	65.8	20.0	13.3	.9	205
Separable lean						74.2	73.5	21.8	3.7	1.0	126
Separable fat						34.8	34.5	14.5	50.5	.5	517
Standard grade:											
Total edible	45	11	44	81	19	67.6	66.8	20.3	12.0	.9	195
Separable lean						74.7	73.9	21.9	3.2	1.0	122
Separable fat						36.9	36.6	15.4	47.5	.5	494
Hindshank:											
Choice grade:											
Total edible	31	15	54	67	33	58.6	58.1	17.8	23.3	.8	286
Separable lean						73.4	72.7	21.7	4.6	1.0	134
Separable fat						27.3	27.0	11.1	61.5	.4	602
Good grade:											
Total edible	31	13	56	70	30	63.7	63.0	19.2	16.9	.9	234
Separable lean						74.2	73.5	21.8	3.7	1.0	126
Separable fat						34.9	34.6	14.5	50.4	.5	517
Standard grade:											
Total edible	29	10	61	75	25	65.8	65.0	19.8	14.3	.9	214
Separable lean						74.9	74.1	21.9	3.0	1.0	121
Separable fat						38.4	38.1	16.1	45.3	.5	477
Loin or short loin:											
Porterhouse steak:											
Choice grade:											
Total edible	50	42	8	54	46	42.8	42.8	13.6	43.0	.6	438
Separable lean						69.9	69.7	21.1	8.2	1.0	164
Separable fat						11.9	11.5	4.2	84.1	.2	777

TABLE 2.—*Physical and chemical composition of carcasses and raw retail cuts before trimming, and of separable lean and separable fat—three grades*—Continued

Description	Physical composition					Chemical composition					
	As purchased			Edible portion		Edible portion					
	Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water		Protein	Fat	Ash	Food energy
						By regression	By difference				
Retail cuts—Continued											
Loin or short loin—Continued											
Porterhouse steak—Continued	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./100 g.*
Good grade:											
Total edible	54	37	9	60	40	47.8	47.6	14.9	36.8	0.7	396
Separable lean						72.5	72.0	21.5	5.5	1.0	141
Separable fat						12.1	11.6	4.3	83.9	.2	775
Standard grade:											
Total edible	61	28	10	68	32	54.2	53.9	16.7	28.7	.7	330
Separable lean						73.3	72.6	21.7	4.7	1.0	135
Separable fat						14.4	14.0	5.3	80.5	.2	749
T-bone steak:											
Choice grade:											
Total edible	48	42	10	53	47	42.0	42.0	13.4	44.0	.6	454
Separable lean						70.0	69.7	21.2	8.1	1.0	163
Separable fat						12.2	11.7	4.3	83.8	.2	774
Good grade:											
Total edible	53	36	11	59	41	47.9	47.7	15.0	36.6	.7	394
Separable lean						72.4	71.9	21.5	5.6	1.0	142
Separable fat						13.3	12.9	4.8	82.1	.2	761
Standard grade:											
Total edible	59	27	14	69	31	54.9	54.5	16.9	27.9	.7	324
Separable lean						72.5	72.0	21.5	5.5	1.0	141
Separable fat						17.2	16.8	6.6	76.4	.2	717
Club steak:											
Choice grade:											
Total edible	47	39	14	54	46	46.6	46.5	14.6	38.3	.6	408
Separable lean						68.0	67.9	20.8	10.3	1.0	182
Separable fat						16.0	15.6	6.0	78.2	.2	731
Good grade:											
Total edible	54	29	17	65	35	52.1	51.8	16.1	31.4	.7	352
Separable lean						70.6	70.3	21.2	7.5	1.0	158
Separable fat						17.3	17.0	6.6	76.2	.2	716
Standard grade:											
Total edible	60	22	18	73	27	59.5	59.0	18.1	22.1	.8	277
Separable lean						72.8	72.2	21.6	5.2	1.0	139
Separable fat						24.1	23.8	9.7	66.2	.3	639
Loin end or sirloin:											
Wedge and round-bone sirloin steak:											
Choice grade:											
Total edible	62	31	7	67	33	52.0	51.7	16.1	31.5	.7	353
Separable lean						72.3	71.8	21.5	5.7	1.0	143
Separable fat						12.3	11.8	4.4	83.6	.2	773
Good grade:											
Total edible	66	27	7	71	29	56.4	55.9	17.3	26.0	.8	308
Separable lean						73.9	73.2	21.8	4.0	1.0	129
Separable fat						14.8	14.4	5.5	79.9	.2	744
Standard grade:											
Total edible	69	22	9	76	24	60.6	60.1	18.4	20.7	.8	265
Separable lean						74.5	73.7	21.9	3.4	1.0	124
Separable fat						18.5	18.1	7.1	74.5	.3	702
Double-bone sirloin steak:											
Choice grade:											
Total edible	55	29	16	66	34	49.7	49.4	15.5	34.4	.7	376
Separable lean						70.7	70.3	21.3	7.4	1.0	158
Separable fat						10.5	10.1	3.6	86.2	.1	793
Good grade:											
Total edible	57	25	18	70	30	55.2	54.8	16.9	27.5	.8	320
Separable lean						73.3	72.6	21.7	4.7	1.0	135
Separable fat						14.3	13.8	5.3	80.7	.2	751

TABLE 2.—*Physical and chemical composition of carcasses and raw retail cuts before trimming, and of separable lean and separable fat—three grades*—Continued

Description	Physical composition					Chemical composition					
	As purchased			Edible portion		Edible portion					
	Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water		Protein	Fat	Ash	Food energy
						By regression	By difference				
Retail cuts—Continued											
Loin end or sirloin—Continued											
Double-bone sirloin steak—Continued	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./100 g.*
Standard grade:											
Total edible	61	20	19	75	25	60.4	59.9	18.3	21.0	0.8	268
Separable lean						74.7	73.9	21.9	3.2	1.0	122
Separable fat						17.7	17.3	6.8	75.7	.2	712
Hipbone sirloin steak:											
Choice grade:											
Total edible	47	39	14	55	45	42.8	42.8	13.6	43.0	.6	446
Separable lean						68.3	68.2	20.9	9.9	1.0	179
Separable fat						12.5	12.0	4.5	83.3	.2	771
Good grade:											
Total edible	51	34	15	60	40	48.4	48.2	15.1	36.0	.7	389
Separable lean						71.4	70.9	21.4	6.7	1.0	152
Separable fat						14.8	14.4	5.5	79.9	.2	744
Standard grade:											
Total edible	54	28	18	66	34	53.3	53.0	16.4	29.9	.7	340
Separable lean						71.8	71.4	21.4	6.2	1.0	147
Separable fat						17.7	17.4	6.8	75.6	.2	711
Short plate:											
Choice grade:											
Total edible	45	45	10	50	50	42.5	42.5	13.5	43.4	.6	449
Separable lean						69.9	69.7	21.1	8.2	1.0	165
Separable fat						15.7	15.3	5.9	78.6	.2	734
Good grade:											
Total edible	49	39	11	56	44	48.0	47.8	15.0	36.5	.7	393
Separable lean						72.0	71.5	21.5	6.0	1.0	146
Separable fat						18.6	18.2	7.2	74.3	.3	701
Standard grade:											
Total edible	54	32	14	63	37	54.2	53.9	16.7	28.7	.7	330
Separable lean						73.2	72.6	21.6	4.8	1.0	136
Separable fat						22.4	22.1	8.9	68.7	.3	658
Rib:											
11th–12th ribs:											
Choice grade:											
Total edible	42	43	15	49	51	39.6	39.7	12.8	47.0	.5	479
Separable lean						66.8	66.9	20.7	11.5	.9	192
Separable fat						13.7	13.3	5.0	81.5	.2	756
Good grade:											
Total edible	46	36	18	57	43	46.7	46.5	14.6	38.2	.7	407
Separable lean						69.8	69.5	21.1	8.4	1.0	166
Separable fat						16.4	16.0	6.2	77.6	.2	726
Standard grade:											
Total edible	52	26	22	66	34	53.8	53.4	16.6	29.2	.8	334
Separable lean						70.9	70.5	21.3	7.2	1.0	156
Separable fat						19.8	19.4	7.7	72.6	.3	688
9th–10th ribs:											
Choice grade:											
Total edible	47	39	14	54	46	41.7	41.7	13.3	44.4	.6	457
Separable lean						66.8	66.9	20.7	11.5	.9	192
Separable fat						12.5	12.0	4.5	83.3	.2	771
Good grade:											
Total edible	51	32	16	61	39	48.6	48.3	15.2	35.8	.7	388
Separable lean						69.9	69.7	21.1	8.2	1.0	164
Separable fat						15.0	14.6	5.6	79.6	.2	742
Standard grade:											
Total edible	56	24	20	70	30	55.4	55.0	17.0	27.2	.8	318
Separable lean						70.2	69.9	21.2	7.9	1.0	162
Separable fat						20.2	19.8	7.9	72.0	.3	683

TABLE 2.—*Physical and chemical composition of carcasses and raw retail cuts before trimming, and of separable lean and separable fat—three grades*—Continued

Description	Physical composition					Chemical composition					
	As purchased			Edible portion		Edible portion					
	Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water		Protein	Fat	Ash	Food energy
						By regression	By difference				
Retail cuts—Continued											
Rib—Continued											
7th–8th ribs:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./100 g.*
Choice grade:											
Total edible	52	33	15	62	38	46.0	45.9	14.5	39.0	0.6	414
Separable lean						67.2	67.3	20.7	11.1	.9	189
Separable fat						13.6	13.2	5.0	81.6	.2	757
Good grade:											
Total edible	55	28	17	66	34	51.6	51.3	16.0	32.0	.7	357
Separable lean						70.1	69.8	21.2	8.0	1.0	163
Separable fat						15.8	15.4	5.9	78.5	.2	733
Standard grade:											
Total edible	59	21	20	74	26	58.1	57.6	17.7	23.9	.8	291
Separable lean						70.9	70.5	21.3	7.2	1.0	156
Separable fat						19.9	19.5	7.8	72.4	.3	686
6th or blade rib:											
Choice grade:											
Total edible	57	29	14	66	34	48.4	48.2	15.1	36.0	.7	389
Separable lean						66.9	66.1	20.5	12.5	.9	200
Separable fat						13.0	12.6	4.7	82.5	.2	764
Good grade:											
Total edible	61	24	15	72	28	54.4	54.0	16.7	28.5	.8	328
Separable lean						69.6	69.3	21.1	8.6	1.0	168
Separable fat						15.1	14.7	5.6	79.5	.2	741
Standard grade:											
Total edible	66	18	17	79	21	60.2	59.6	18.3	21.3	.8	270
Separable lean						71.2	70.8	21.3	6.9	1.0	153
Separable fat						17.6	17.3	6.7	75.8	.2	712
Round:											
Round steak:											
Choice grade:											
Total edible	78	18	4	81	19	62.6	62.0	18.9	18.2	.9	245
Separable lean						73.1	72.5	21.6	4.9	1.0	136
Separable fat						17.4	17.0	6.7	76.1	.2	715
Good grade:											
Total edible	81	15	4	84	16	66.2	65.3	19.9	13.8	1.0	209
Separable lean						74.7	73.9	21.9	3.2	1.0	122
Separable fat						21.5	21.1	8.5	70.1	.3	669
Standard grade:											
Total edible	83	12	5	87	13	69.2	68.3	20.7	10.0	1.0	179
Separable lean						75.6	74.8	22.0	2.2	1.0	114
Separable fat						26.0	25.6	10.5	63.5	.4	618
Heel of round:											
Choice grade:											
Total edible	76	24	0	76	24	61.6	61.0	18.7	19.5	.8	256
Separable lean						73.9	73.2	21.8	4.0	1.0	129
Separable fat						23.7	23.3	9.5	66.9	.3	644
Good grade:											
Total edible	80	20	0	80	20	65.5	64.8	19.7	14.6	.9	216
Separable lean						74.5	73.7	21.9	3.4	1.0	124
Separable fat						27.4	27.0	11.2	61.4	.4	602
Standard grade:											
Total edible	86	14	0	86	14	69.2	68.4	20.7	10.0	.9	179
Separable lean						75.8	74.9	22.1	2.0	1.0	112
Separable fat						29.9	29.6	12.3	57.7	.4	573
Rump:											
Choice grade:											
Total edible	54	33	13	63	37	50.0	49.8	15.5	34.0	.7	373
Separable lean						70.6	70.3	21.2	7.5	1.0	158
Separable fat						16.4	16.0	6.2	77.6	.2	726

TABLE 2.—*Physical and chemical composition of carcasses and raw retail cuts before trimming, and of separable lean and separable fat —three grades*—Concluded

Description	Physical composition					Chemical composition					
	As purchased			Edible portion		Edible portion					
	Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water		Protein	Fat	Ash	Food energy
						By regression	By difference				
Retail cuts—Continued											
Rump—Continued	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./ 100 g.*
Good grade:											
Total edible	58	28	14	67	33	55.2	54.8	16.9	27.5	0.8	320
Separable lean	-------	-------	-------	-------	-------	72.6	72.0	21.6	5.4	1.0	141
Separable fat	-------	-------	-------	-------	-------	19.4	19.0	7.5	73.2	.3	692
Standard grade:											
Total edible	59	25	16	70	30	58.8	58.3	17.9	23.0	.8	284
Separable lean	-------	-------	-------	-------	-------	73.9	73.2	21.8	4.0	1.0	129
Separable fat	-------	-------	-------	-------	-------	22.0	21.6	8.7	69.4	.3	663

With the percentage of fat in each cut determined, it was decided that relationships *within* the cut would be the basis for further determinations. The percentage of chemical fat in a cut was related to the bone content of the same cut by means of the curves illustrated in figure 4. In the same way, the chemical fat was related to the separable fat of the same cut, illustrated in figure 5. The percentage of separable lean was calculated by difference, and physical composition for all cuts was then complete. In this way, the data for separable fat, separable lean, and bone for each cut for each of three grades were derived. The data are shown in table 2 on the "as purchased" and "edible portion" bases.

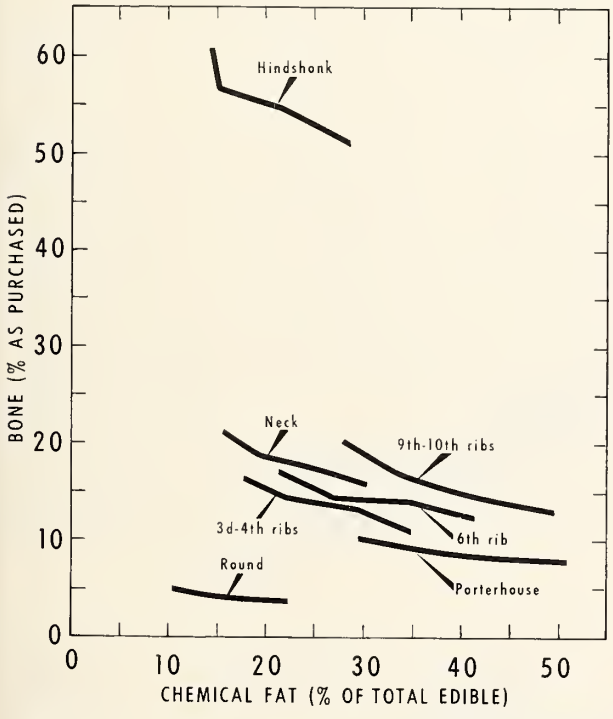

Figure 4.—Bone as purchased and chemical fat in edible portion of cut.

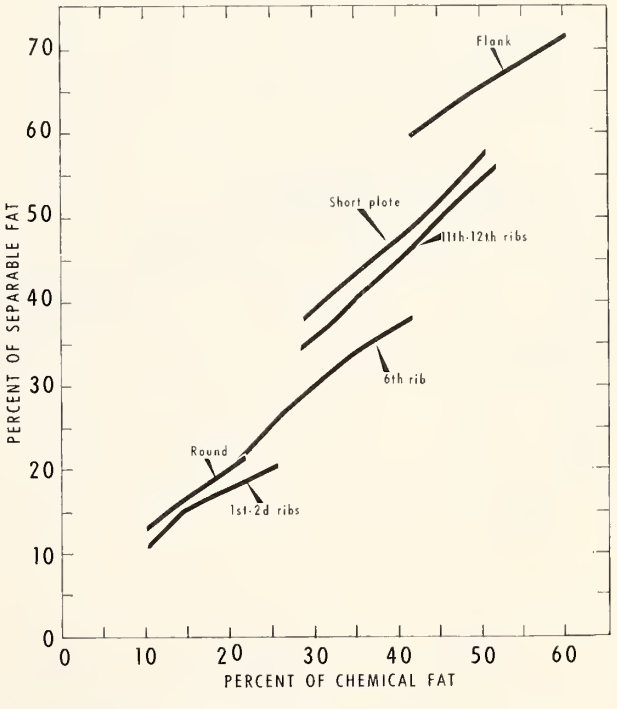

Figure 5.—Chemical and separable fat in edible portion of cut.

The relationships of chemical nutrients within the cuts were determined next. Regressions were calculated of chemical fat in the separable fat, and of chemical fat in the separable lean, on the chemical fat in the entire edible portion. Water and protein were then related to chemical fat in each of the three portions. Since the relationships among these nutrients were similar for all cuts, the analytical data from the Illinois study for all cuts and all grades were combined and regression equations derived for water and protein.

Separate equations were calculated for lean, for fat tissue, and for total edible. The curves for the three portions are similar in relationships, as shown in figures 6 and 7. The regression equations are shown below.

Regressions	Correlation coefficient	Standard error (SE)[1]	Number of samples
Total edible:			
% water = 77.18 − 0.80 × % fat	−0.998**	0.60	76
% protein = 22.85 − 0.21 × % fat	−0.98**	0.46	75
Separable lean:			
% water = 77.71 − 0.95 × % fat	−0.98**	0.63	80
% protein = 22.36 − 0.15 × % fat	−0.73**	0.51	79
Separable fat:			
% water = 69.21 − 0.68 × % fat	−0.99**	0.88	76
% protein = 29.92 − 0.31 × % fat	−0.97**	0.63	76

[1] Standard error of estimate. **Significant at the 1-percent level.

Table 2 shows the physical and chemical data for each cut, the separable lean, and separable fat, all calculated from the above equations at the average fat content for each of the three most important grades.

The percentage of ash was read from the regression curves for lean meat and "visible" fat in Department Circular 389 (*4, pp. 8* and *9*), and calculated for the entire cut by combining lean and separable fat in the proportions indicated in table 2 for each cut.

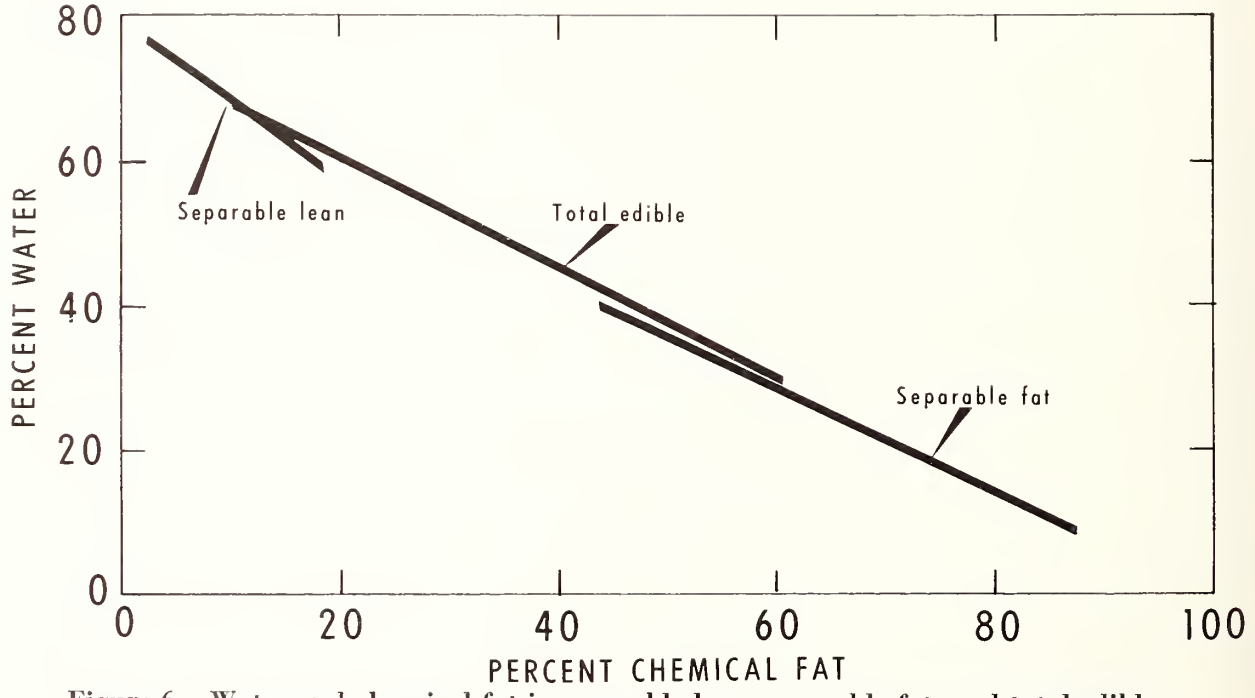

Figure 6.—Water and chemical fat in separable lean, separable fat, and total edible.

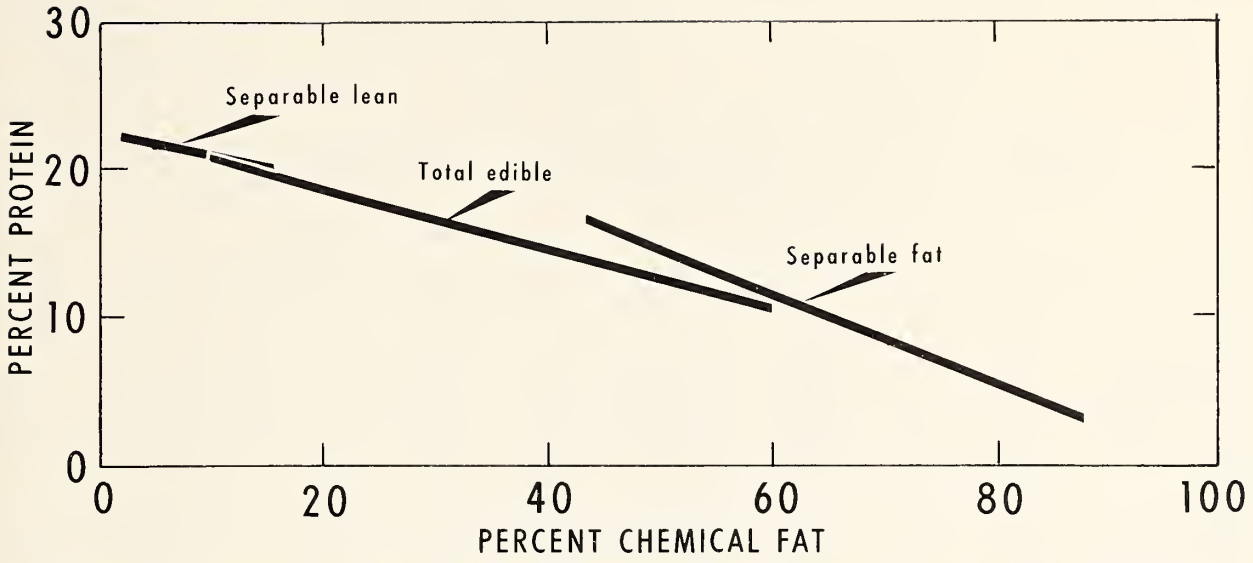

Figure 7.—Protein and chemical fat in separable lean, separable fat, and total edible.

COMPOSITION OF TRIMMED RETAIL CUTS

We can now consider the effect on composition of trimming the cuts to the retail basis. As mentioned previously, retail trimming is extremely variable so that no one set of values can be expected to apply to all situations. It was hoped, however, that some indication of "average" trimming might be obtained.

The Agricultural Marketing Service supplied results from a large-scale study with the industry, in which retail cuts were trimmed to relatively uniform levels. In addition, two chain stores furnished data based on their own test-cutting operations.

These studies were based on large numbers of samples, and represented trimming under good commercial practice to about ½ inch or less surface fat. There was wide variation in the amounts of fat removed from some of the cuts. In a few instances, straight averages of the three studies would have resulted in inconsistencies. The final figures selected for use, therefore, represent our best judgment as to the most representative values for certain cuts. Table 3 shows the amount of trim applied and the distribution of lean, of fat tissue, and of bone after trimming cuts of average physical composition as shown.

The amount of fat trim, expressed as percentage of the entire cut, is subtracted from the total separable fat, also expressed in percentage of the cut. Each of the physical components—lean, remaining fat, and bone—is then divided by the total weight after trimming, to derive the proportions of each in the trimmed cut.

The physical composition data can be adjusted in this way to any desired fat trim. The chemical composition of a cut can then be calculated from the appropriate nutritive values in table 2 for separable lean and separable fat, weighting each part according to its proportion in a given cut.

As an example, the protein in the edible portion of foreshank, Choice grade, was calculated, using the proportions of separable lean and separable fat as calculated above but expressed as percent of the edible portion (47.1% lean÷56.3% edible portion=83.7% lean in edible portion; 9.2% separable fat÷56.3% edible portion=16.3% separable fat in edible portion). The proportions of separable lean and separable fat are multiplied by the percentage of protein in each part shown in table 2, as follows: (83.7% separable lean × 21.7% protein + 16.3% separable fat × 11.3% protein) ÷ 100 =20.0% protein in the edible portion. The same proportions of separable lean and separable fat are applied to the water, fat, and ash to calculate the content of each in the cut.

Table 4 shows the composition of the cuts of three grades after trimming in the amounts indicated in table 3.

TABLE 3.—*Physical composition of retail cuts of three grades*

Description	Choice grade							Good grade		
	Physical composition Untrimmed cut			Fat trim	Physical composition Trimmed cut			Physical composition Untrimmed cut		
	Lean	Fat	Bone		Lean	Fat	Bone	Lean	Fat	Bone
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Brisket	44.1	44.2	11.7	25	58.8	25.6	15.6	48.1	38.5	13.4
Chuck cuts:										
5th rib	55.9	29.5	14.6	6	59.5	25.0	15.5	60.9	23.3	15.8
3d–4th ribs	60.9	26.1	13.0	6	64.8	21.4	13.8	64.2	21.6	14.2
1st–2d ribs	71.1	15.0	13.9	4	74.0	11.5	14.5	73.1	13.1	13.8
Arm	63.3	28.1	8.6	18	77.2	12.3	10.5	66.5	24.0	9.5
Neck	59.0	23.7	17.3	13	67.8	12.3	19.9	61.5	20.0	18.5
Flank	32.0	68.0	0.	68	100.0	0.	0.	36.0	64.0	0.
Foreshank	44.8	13.7	41.5	5	47.1	9.2	43.7	45.8	12.0	42.2
Hindshank	30.9	15.2	53.9	0	30.9	15.2	53.9	31.3	12.8	55.9
Loin cuts:										
Porterhouse steak	49.7	42.1	8.2	13	57.2	33.4	9.4	54.5	36.7	8.8
T-bone steak	47.6	42.5	9.9	13	54.7	33.9	11.4	52.9	36.1	11.0
Club	46.6	39.2	14.2	13	53.6	30.1	16.3	54.5	28.9	16.6
Sirloin cuts:										
Wedge and round-bone sirloin	62.4	30.9	6.7	8	67.8	24.9	7.3	65.9	26.7	7.4
Double-bone sirloin	54.7	28.8	16.5	8	59.5	22.6	17.9	57.3	24.6	18.1
Hipbone sirloin	47.3	38.7	14.0	8	51.4	33.4	15.2	51.0	34.0	15.0
Short plate	45.4	45.0	9.6	13	52.2	36.8	11.0	49.4	39.2	11.4
Ribs:										
11th-12th ribs	41.7	43.1	15.2	[1] 24	50.7	40.9	8.5	46.5	35.5	18.0
9th-10th ribs	46.6	39.3	14.1	[1] 23	55.7	36.7	7.7	51.4	32.3	16.3
7th-8th ribs	52.5	32.6	14.9	[1] 22	61.9	30.0	8.1	54.9	27.6	17.5
6th or blade rib	56.7	29.4	13.9	[1] 21	65.9	26.7	7.5	61.5	23.9	14.6
Round	77.8	18.5	3.7	10	86.5	9.4	4.1	80.7	15.3	4.0
Heel of round	75.5	24.5	0.	10	83.9	16.1	0.	80.5	19.5	0.
Rump	54.4	32.6	13.0	14	63.3	21.6	15.1	58.0	28.0	14.0

[1] Includes bone and lean removed as trim and as shortribs.

before and after trimming—percentage of entire cuts, with bone

Good grade—Continued							Standard grade			
Fat trim	Physical composition Trimmed cut			Physical composition Untrimmed cut			Fat trim	Physical composition Trimmed cut		
	Lean	Fat	Bone	Lean	Fat	Bone		Lean	Fat	Bone
Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
20	60.1	23.1	16.8	51.1	34.0	14.9	15	60.1	22.4	17.5
2	62.2	21.7	16.1	64.5	16.5	19.0	0	64.5	16.5	19.0
2	65.5	20.0	14.5	67.4	15.9	16.7	0	67.4	15.9	16.7
0	73.1	13.1	13.8	75.1	9.2	15.7	0	75.1	9.2	15.7
16	79.2	9.5	11.3	69.0	20.8	10.2	14	80.2	7.9	11.9
8	66.9	13.0	20.1	62.3	16.3	21.4	5	65.6	11.9	22.5
64	100.0	0.	0.	41.3	58.7	0.	59	100.0	0.	0.
4	47.7	8.3	44.0	44.8	10.7	44.5	3	46.2	7.9	45.9
0	31.3	12.8	55.9	29.5	9.8	60.7	0	29.5	9.8	60.7
6	57.9	32.7	9.4	61.0	28.5	10.5	3	62.9	26.3	10.8
6	56.3	32.0	11.7	59.2	27.1	13.7	3	61.1	24.8	14.1
6	57.9	24.4	17.7	59.5	22.2	18.3	3	61.3	19.8	18.9
5	69.4	22.8	7.8	69.3	21.9	8.8	4	72.2	18.6	9.2
5	60.3	20.6	19.1	61.2	19.9	18.9	4	63.7	16.6	19.7
5	53.7	30.5	15.8	54.4	27.9	17.7	4	56.7	24.9	18.4
9	54.3	33.2	12.5	53.7	32.1	14.2	5	56.6	28.5	14.9
[1] 24	56.3	33.6	10.0	52.0	26.5	21.5	[1] 24	62.9	25.1	12.0
[1] 23	61.1	30.0	8.9	55.9	23.9	20.2	[1] 23	66.7	22.2	11.1
[1] 22	64.9	25.5	9.5	58.5	21.0	20.5	[1] 23	69.4	19.5	11.1
[1] 20	70.9	21.5	7.7	65.6	17.6	16.8	[1] 20	75.3	15.8	8.9
7	86.8	8.9	4.3	83.1	12.4	4.5	7	89.4	5.8	4.8
7	86.6	13.4	0.	85.8	14.2	0.	7	92.3	7.7	0.
10	64.4	20.0	15.6	58.7	25.3	16.0	10	65.2	17.0	17.8

TABLE 4.—*Physical and chemical composition of raw retail cuts after trimming—three grades*

Description	Physical composition					Chemical composition				
	As purchased [1]			Edible portion		Edible portion				
	Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water (By difference)	Protein	Fat	Ash	Food energy
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./100 g.*
Carcass, total edible:										
Choice grade	64	21	15	75	25	56.7	17.4	25.1	0.8	301
Good grade	66	19	15	78	22	60.3	18.5	20.4	.8	263
Standard grade	68	15	17	82	18	63.9	19.4	15.8	.9	225
Retail cuts, total edible:										
Brisket:										
Choice grade	59	26	16	70	30	53.2	16.5	29.5	.8	337
Good grade	60	23	17	72	28	56.7	17.5	24.8	.8	298
Standard grade	60	22	18	73	27	58.8	18.1	22.3	.8	278
Chuck cuts:										
Entire chuck (1st–5th ribs, arm, and neck):										
Choice grade	69	15	16	82	18	60.8	18.7	19.6	.9	257
5th rib:										
Choice grade	59	25	16	70	30	51.7	16.2	31.4	.7	352
Good grade	62	22	16	74	26	56.3	17.5	25.3	.8	303
Standard grade	64	17	19	80	20	61.4	18.9	18.8	.9	250
3d–4th ribs:										
Choice grade	65	21	14	75	25	55.1	17.2	26.8	.8	315
Good grade	66	20	14	77	23	58.8	18.2	22.1	.8	277
Standard grade	67	16	17	81	19	62.7	19.4	17.0	.9	236
1st–2d ribs:										
Choice grade	74	11	15	87	13	62.3	19.2	17.6	.9	241
Good grade	73	13	14	85	15	64.0	19.5	15.5	.9	223
Standard grade	75	9	16	89	11	67.9	20.6	10.6	.9	184
Arm:										
Choice grade	77	12	11	86	14	64.2	19.4	15.5	.9	223
Good grade	79	10	11	89	11	67.3	20.3	11.6	.9	191
Standard grade	80	8	12	91	9	69.4	20.7	8.9	.9	169
Neck:										
Choice grade	68	12	20	85	15	63.8	19.4	15.9	.9	226
Good grade	67	13	20	84	16	64.8	19.8	14.6	.9	216
Standard grade	66	12	23	85	15	66.4	20.2	12.5	.9	199
Flank steak:										
Choice grade	100	0	0	100	0	71.7	21.6	5.7	1.0	144
Good grade	100	0	0	100	0	72.1	21.8	5.1	1.0	139
Standard grade	100	0	0	100	0	72.9	21.9	4.2	1.0	131
Foreshank:										
Choice grade	47	9	44	84	16	65.4	20.0	13.7	.9	209
Good grade	48	8	44	85	15	67.7	20.7	10.7	.9	185
Standard grade	46	8	46	85	15	68.4	20.9	9.6	.9	176
Hindshank:										
Choice grade	31	15	54	67	33	57.6	18.2	23.4	.8	289
Good grade	31	13	56	71	29	62.3	19.7	17.2	.8	239
Standard grade	30	10	61	75	25	65.1	20.4	13.6	.9	210
Loin or short loin:										
Porterhouse steak:										
Choice grade	57	33	9	63	37	48.3	14.8	36.2	.7	390
Good grade	58	33	9	64	36	50.2	15.3	33.8	.7	370
Standard grade	63	26	11	71	29	55.3	16.9	27.0	.8	316
T-bone steak:										
Choice grade	55	34	11	62	38	47.5	14.7	37.1	.7	397
Good grade	56	32	12	64	36	50.6	15.4	33.3	.7	366
Standard grade	61	25	14	71	29	56.0	17.2	26.0	.8	308
Club steak:										
Choice grade	54	30	16	64	36	49.1	15.5	34.8	.7	380
Good grade	58	24	18	70	30	54.5	16.9	27.9	.8	324
Standard grade	61	20	19	76	24	60.4	18.7	20.1	.8	261

See footnotes at end of table.

TABLE 4.—*Physical and chemical composition of raw retail cuts after trimming—three grades*—Continued

Description	Physical composition					Chemical composition				
	As purchased [1]			Edible portion		Edible portion				
	Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water, by difference	Protein	Fat	Ash	Food energy
Retail cuts, total edible—Continued										
Loin end or sirloin:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./ 100 g.*
Wedge and round-bone sirloin steak:										
Choice grade	68	25	7	73	27	55.7	16.9	26.7	0.8	313
Good grade	69	23	8	75	25	58.7	17.8	22.7	.8	281
Standard grade	72	19	9	80	20	62.2	18.9	18.0	.9	243
Double-bone sirloin steak:										
Choice grade	59	23	18	72	28	53.7	16.4	29.1	.8	333
Good grade	60	21	19	75	25	57.6	17.6	24.1	.8	293
Standard grade	64	17	20	79	21	62.2	18.8	18.2	.8	244
Hipbone sirloin steak:										
Choice grade	51	33	15	61	39	46.0	14.5	38.8	.7	412
Good grade	54	31	16	64	36	50.4	15.7	33.2	.7	367
Standard grade	57	25	18	69	31	54.9	17.0	27.4	.8	320
Short plate:										
Choice grade	52	37	11	59	41	47.2	14.8	37.3	.7	400
Good grade	54	33	13	62	38	51.3	16.1	31.9	.7	356
Standard grade	57	28	15	67	33	55.7	17.4	26.2	.8	311
Rib:										
Entire rib (6th–12th ribs):										
Choice grade	59	33	8	64	36	47.2	14.8	37.4	.6	401
11th–12th ribs:										
Choice grade	51	41	8	55	45	43.0	13.7	42.7	.6	444
Good grade	56	34	10	63	37	49.5	15.5	34.3	.7	376
Standard grade	63	25	12	71	29	55.9	17.4	25.8	.8	307
9th–10th ribs:										
Choice grade	56	37	8	60	40	45.1	14.3	40.0	.6	422
Good grade	61	30	9	67	33	51.6	16.0	31.7	.7	354
Standard grade	67	22	11	75	25	57.4	17.9	23.9	.8	292
7th–8th ribs:										
Choice grade	62	30	8	67	33	49.7	15.6	34.1	.7	374
Good grade	65	26	10	72	28	54.4	16.9	27.9	.8	324
Standard grade	69	20	11	78	22	59.4	18.3	21.5	.8	272
6th or blade rib:										
Choice grade	66	27	7	71	29	50.7	16.0	32.7	.7	363
Good grade	71	21	8	77	23	56.6	17.5	25.0	.8	300
Standard grade	75	16	9	83	17	61.6	18.8	18.8	.9	250
Round:										
Entire round (round steak and heel of round):										
Choice grade	86	11	3	89	11	66.6	20.2	12.3	.9	197
Round steak:										
Choice grade	86	9	4	90	10	67.1	20.2	11.9	.9	194
Good grade	87	9	4	91	9	69.0	20.7	9.4	.9	173
Standard grade	89	6	5	94	6	71.8	21.3	6.0	1.0	145
Heel of round:										
Choice grade	84	16	0	84	16	65.2	19.8	14.2	.9	213
Good grade	87	13	0	87	13	67.4	20.5	11.1	.9	188
Standard grade	92	8	0	92	8	71.5	21.3	6.2	1.0	147
Rump:										
Choice grade	63	22	15	75	25	56.5	17.4	25.3	.8	303
Good grade	64	20	16	76	24	59.4	18.3	21.4	.8	271
Standard grade	65	17	18	79	21	62.5	19.1	17.6	.8	240
Hamburger (ground beef):										
Regular ground [2]						60.2	17.9	21.2	.7	268
Lean ground [3]						68.3	20.7	10.0	1.0	179

[1] Some cuts add to 100 ±1 percent because of rounding.

[2] Regular market hamburger is not sold by grade. These averages represent a nationwide sampling of several hundred analyses. They are shown here for further use in the section on cooked meat.

[3] Based on untrimmed round steak, standard grade.

Previous estimates of the composition of cooked meats published by this agency have already been mentioned. These estimates were never entirely satisfactory because, in the case of averages, they did not reflect the composition of cuts currently on the market, and in the case of values developed in relation to raw meats, the data were insufficient for confidence in generalizations from them. Many studies in the literature have indicated the various factors that affect the composition of cooked meat, including method of cooking, temperature, and time. The problem for many years seemed too complex for solution. But we believed that, despite all the variables involved, the composition of the raw meat must be one of the most important determinants of the composition of the cooked product. Since we had found that regression analysis described many of the physical and chemical relationships of raw meat, we turned to this technique to study the relationships of raw to cooked products.

For analysis of the composition of cooked beef, it was essential that the raw control sample have precisely the same composition as the sample used for cooking, because the exact relationships may be completely obscured by minor differences in samples considered to be paired if losses of a given nutrient are small. This in itself is a difficult goal to achieve, as was shown by Grindley (*12*). In Grindley's study, a round of beef was cut into eight portions completely trimmed of visible fat, and cut into as nearly similar portions as possible. Even under these conditions, his results on four alternate samples of this round of beef gave a range of 21.53 to 23.09 percent protein and 2.71 to 3.46 percent fat, a difference of 1.56 percentage points for protein and 0.75 percentage points for fat content of completely lean meat. Although these differences are small in magnitude, they are proportionately large (7 percent and 27 percent, respectively). Actual losses of protein and fat in cooking have been reported that are smaller than these differences. Such deviations in sampling could, therefore, completely distort the true relationships between raw and cooked samples.

Some investigators still "pair" raw and cooked samples in this way and thus invalidate their results. More accurate pairing can be obtained when a cooked cut of meat serves as its own control. This can be done if nothing is lost except water in evaporation inasmuch as the cooked drained meat, drippings, and water in evaporation, taken together, comprise all the material present in the raw meat. The cut is weighed before and after cooking to determine evaporation, and the nutrients in the drippings and drained meat are determined separately by chemical analysis. The composition of the raw cut can then be computed from the data on drippings, drained meat, evaporation, and the appropriate proportions of these components. The necessary information for this type of raw control sample was available in only a few sources. For the present analysis, preference was given to studies in which the raw control data were derived in this manner.

The second choice in selecting values was given to samples paired from right and left sides of the same animal. No studies in which pairing was carried out by less precise methods were accepted.

After selecting the data for paired samples on these two bases, the next step was to calculate the percentages of nutrients in the cooked samples to the raw basis; that is, the percentage of a given nutrient in the cooked drained cut was multiplied by the yield of the cooked drained cut expressed in percentage of the raw weight. This provided a further check on the accuracy of reported results. When the values calculated in this way were compared with the quantities of the nutrients in the raw control, some samples showed an apparent increase in one or more nutrients after cooking. An actual increase in a nutrient after cooking is, of course, impossible so this was taken as an indication of error in technique; such values were eliminated from subsequent calculations.

Very few of the studies available met the rigid criteria outlined above. The early reports from the Office of Experiment Stations (*12*, *13*, *14*) were based on studies carried out with meticulous care and, though the cuts of meat and cooking procedures differed in some instances from current practices, they yielded the necessary data for the present purpose. Another extremely valuable study was published in 1955 by Toepfer and others (*28*), and the unpublished results on individual samples from that research were made available for our use. In that carefully planned study, all cuts of eight beef carcasses were analyzed. Paired cuts from opposite sides were taken, one of the pair being analyzed before cooking and the other after cooking. Also, the necessary data are given for reconstructing the composition of the raw cuts from the cooked components, drained meat, dripping loss, and evaporation, thus providing an excellent check on the two methods. Other sources used are listed on p. 32.

Development of the Technique

It was assumed that the composition of cooked meat depended to some undetermined extent on the composition of the raw meat from which it was prepared and on the amount of weight lost in cooking. Preliminary investigations showed that simple correlations between the composition of the raw and that of the cooked meat for each of the components—protein and fat—were very high, and it was possible to obtain regressions that could be used for predicting the amount of the respective nutrients in the cooked meat.

A simple regression of a nutrient in the cooked cut calculated to the raw basis on the corresponding nutrient in the raw cut yielded the most satisfactory

results for protein, fat, and ash. The nutrient in the raw cut was that determined by chemical analysis and reported as such by the investigator, or was computed by us from analytical data on the cooked drained cut and on the drippings plus the evaporation as described above. The nutrient in the cooked cut calculated to the raw basis was the percentage as determined by chemical analysis multiplied by the yield after cooking.

This calculation may be illustrated by the following example:

	Nutrients in raw meat	Nutrients in cooked meat	Nutrients in cooked meat
	Percent	*Percent*	*Percent of raw weight*
	(a)	(b)	(c)
Water	67.0	51.9	33.2
Protein	19.5	29.9	19.1
Fat	12.7	17.6	11.2
Ash	.8	1.0	.6
Weight loss			36.1
Cooked yield			63.9

The nutrients in percentage of the cooked meat (column b) are multiplied by the yield of cooked meat (63.9 percent) to calculate the nutrients in the cooked meat in percentage of the raw weight (column c). The relations used in the regression equations were those between columns a and c.

The simple correlation was not as high for water as for other nutrients, so another approach was used. It has been found that the weight loss is related to the degree of doneness, and that degree of doneness has a relation with the amount of water lost. The relation between weight loss and percentage of original water lost was investigated and found to be sufficiently high to use in predicting the water in the cooked piece. The procedure requires an additional step in the calculations. The water remaining in the cooked cut (33.2 percent) is subtracted from the original water (67.0 percent), giving a loss of 33.8 percent. Dividing this value by the water in the raw meat, 33.8÷67.0 gives 50.4 percent of the water in the raw meat lost in cooking. The relation of this value to the total weight loss in percent gave a better basis for predicting water in the cooked cut than was otherwise obtained.

At this point we had reasonable measures for predicting the values for the three most important components—water, protein, and fat. The value for the remaining component—ash—could be arrived at, although with less assurance, in a fashion similar to that for protein and fat. With the data calculated in this way, the content of any nutrient in cooked meat may be estimated directly from the proportions of that nutrient in the raw meat and the weight lost in cooking.

The analytical data were grouped into four classes: roasts cooked by dry heat; cuts and pieces cooked by moist heat; steaks cooked by broiling, braising, and sauteing; and ground beef cooked by broiling and sauteing. Each of these classes had, for one or more nutrients, regression equations that differed significantly from those of the other classes. Within each class, no breakdown appeared to be necessary for cuts from different parts of the animal.

A discussion of the relationships indicated by the equations and some details on the samples included in each class are given in the following sections.

Beef Roasts Cooked by Dry-heat Methods

All acceptable data on roasts of beef, regardless of cut, cooked by dry heat were grouped together. These cuts included blade roll, inside of round, knuckle of round, loin strip, sirloin butt, spencer roll, and tenderloin from Toepfer and others (location of these cuts is shown in Tech. Bul. 1137 (*28*)) and ribs and round from other studies. All cuts were boneless. The range in fat content in the raw cuts was from 1.0 percent to 44.6 percent. The oven temperatures used, insofar as they were stated, ranged from 149° C. to 260° C. Internal temperatures to which the roasts were cooked were represented by the following numbers of samples for the four constituents:

Roasts cooked by dry heat—distribution of samples by stage of doneness for each nutrient

Stage of doneness	Temperature	Water	Protein	Fat	Ash
		Samples	*Samples*	*Samples*	*Samples*
Rare	65° C.	11	—	4	—
Medium	74° C.	28	28	28	28
Well-done	79°–80° C.	16	2	6	—
Unknown		2	2	2	2

The regression equations therefore reflect the influence of the large proportion of roasts cooked to medium doneness. It would be highly desirable to have sufficient samples at each stage of doneness to calculate separate equations for rare, medium, and well-done meats. Combining these stages into one set may have the effect of increasing the standard errors of estimate in the equations we have derived, but in lieu of more comprehensive data we have put them together.

It will be noted (p. 23) that among the correlation coefficients for the nutrients in roasts cooked by dry heat, the lowest value is the one relating water in the cooked and water in the raw meat, 0.80. Since water accounts for most of the loss in weight in cooking, and therefore affects the concentration of all other nutrients on the cooked basis, the second approach to calculating it was attempted; in the raw cut, the percentage of water lost in cooking was related to the percentage of weight lost in cooking. The resulting correlation coefficient 0.93 is much higher, and it is recommended that this equation be used for moisture calculations. However, the first set of data, relating water in raw meat to water in cooked meat, is shown on page 23, for information.

Beef Steaks; Broiled, Braised, and Sauteed

The cuts represented among the steaks included the same ones from Technical Bulletin 1137 (*28*)

described under dry-heat roasts, and in addition other cuts from the round, loin, rib, and chuck. Insofar as thickness was described, the steaks were ¾ inch or 1 inch thick. Cooking methods included pan- and oven-broiling, braising, sauteing. Internal temperatures are difficult to determine in steaks, so very few studies reported this type of information. However, judging from length of cooking—from 10 to 45 minutes—it seems reasonable to suppose that doneness ranged from rare to well-done or overdone. The regression equations are shown on page 23.

Ground Beef: Pan-broiled, Oven-broiled, Sauteed

Most of the samples of ground beef were from the round. In addition, one sample was ground rump, and five were described as "chopped beef" with varying proportions of added fat. All samples were pan- or oven-broiled except one, which was sauteed. No samples with added ingredients were used. The results of our statistical analysis are shown on page 23.

The results for ground beef are the least impressive of all, especially for fat content. Furthermore, market hamburger, which usually ranges between 20 and 30 percent fat or even higher, is very poorly represented in this sampling. The five samples of chopped beef with added fat, for which fat only was determined, show an entirely different relationship between fat in raw meat and fat in cooked meat from all other samples. Nonetheless, the samples with added fat are included in the regression analysis for fat. The other samples include only one that is above 16 percent fat. It is possible, therefore, that very fat hamburger should be handled separately from ground lean beef, but not enough samples are available at this time to establish this fact.

Cuts Cooked by Moist-heat Methods

This class includes large pieces of meat and small cubed pieces cooked by moist heat. Some of the samples were cooked in covered vessels without added water, and others with varying amounts of added water. The cuts represented were round, plate, neck, rib, brisket, chuck, clod, rump butt, and shoulder arm. Degree of doneness was given in only one study (98° C.), but the length of the cooking periods would indicate that all samples were well-done or overdone. The regression equations are shown on page 23.

Although the correlation coefficient for protein in cuts cooked by moist heat is lower than those for other groups, it is not significantly different from the figure for ground beef. The coefficient for ash is also low but is not significantly different from that for ground beef. Some of the protein fractions and some of the ash constituents are soluble in water, and there may be a direct relation between the relative proportions of water used and the amount of exposed surface. The only evidence of this that could be deduced from the descriptions is that the samples that were cut into cubes and presumably completely submerged in water retained less protein and less ash than did all samples combined. The values for these small pieces did not, however, present a completely discrete distribution; they overlapped the range of the large pieces.

For ash, the error introduced by using a regression equation based on data that are so poorly correlated can be disregarded for dietary calculations, since ash occurs in very small quantities.

However, for protein it would be desirable to have a curve of better fit. Studies relating the amount of water to the area of exposed surface might throw some light on this matter.

It is more difficult, however, to explain the relatively low correlations for protein and ash in ground beef. The reasons for the lack of closer relationships between raw and cooked ground beef should be carefully explored through additional studies.

In table 5 (p. 23) are summarized the results of the statistical analysis of the four classes of beef—roasts, dry-heat; steak; ground beef; and cuts cooked by moist heat. The regression curves are shown on the graphs that follow (figs. 8–11).

The data on trimmed cuts in table 4 and separable lean in table 2 have been calculated to the cooked basis, by the above method. The values for average losses in weight are from Pecot and Watt (*20*). The composition values derived for the cooked meat are shown in table 6.

TABLE 5.—*Relation of cooked beef to raw beef—summary*

[X_2=protein in raw (%)
X_3=fat in raw (%)
X_4=ash in raw (%)
X_1=water in raw (%)
X_5=weight loss (%)

Y_2=protein in cooked (% of raw weight)
Y_3=fat in cooked (% of raw weight)
Y_4=ash in cooked (% of raw weight)
Y_1=water in cooked (% of raw weight)
Y_5=water lost (% of original water)]

Regression	Correlation coefficient	Standard error (SE)[1]	Number of samples
ROASTS, DRY-HEAT			
$Y_2=-0.14+0.99\ X_2$	0.99**	0.19	32
$Y_3=1.09+.74\ X_3$	.98**	1.54	40
$Y_4=-0.03+.93\ X_4$	.96**	.06	30
$Y_1=-9.01+.71\ X_1$	.80**	5.36	57
$Y_5=.76+1.39\ X_5$	.93**	3.25	59
STEAKS; BROILED, BRAISED, AND SAUTEED			
$Y_2=0.05+.98\ X_2$	.99**	.78	63
$Y_3=.12+.86\ X_3$	.93**	3.16	69
$Y_4=.05+.91\ X_4$	.98**	.03	34
$Y_1=.84+.51\ X_1$	.56**	5.95	73
$Y_5=20.95+.82\ X_5$	.76**	5.36	73
GROUND BEEF; PAN-BROILED, OVEN-BROILED, SAUTEED			
$Y_2=-0.06+.98\ X_2$	.87**	.69	42
$Y_3=2.74+.56\ X_3$	.84**	2.99	43
$Y_4=.77+.22\ X_4$	[2].29	.08	15
$Y_1=26.80+.28\ X_1$	[2].22	5.92	63
$Y_5=3.3+1.27\ X_5$	.94**	3.13	63
BEEF COOKED BY MOIST-HEAT METHODS			
$Y_2=4.60+.71\ X_2$	.78**	1.22	131
$Y_3=.01+.84\ X_3$	.97**	1.83	148
$Y_4=.17+.36\ X_4$	.34**	.05	124
$Y_1=21.42+.20\ X_1$	.20**	6.78	146
$Y_5=9.4+1.05\ X_5$	.93**	3.84	137

[1] Standard error of estimate.
** Significant at the 1-percent level.
[2] Not significant.

An example of the computations for one item—brisket, total edible, Choice grade, cooked by moist heat—is as follows:

	Nutrients in cooked meat from 100 grams, raw
	Grams
Protein = 4.60 + (0.71)(16.5) =	16.32
Fat = 0.01 + (0.84)(29.5) =	24.79
Ash = 0.17 + (0.36)(0.8) =	.46
Water retained = 53.2 − 23.43 =	29.77
[Water lost = 9.4 + (1.05)(33.0) = 44.05; then 53.2 × 44.05 = 23.43]	
Total	71.34

The nutrients in the cooked meat may be expressed as percentages of the cooked cut by dividing each nutrient by the total. The values for brisket as calculated above, when expressed as percentages of the cooked cut, are as follows:

	Nutrients in the 71.34 grams cooked meat
	Percent
Protein	22.9
Fat	34.8
Ash	.6
Water	41.7
	100.0

The percentage values for cooked meats are the ones shown in table 6.

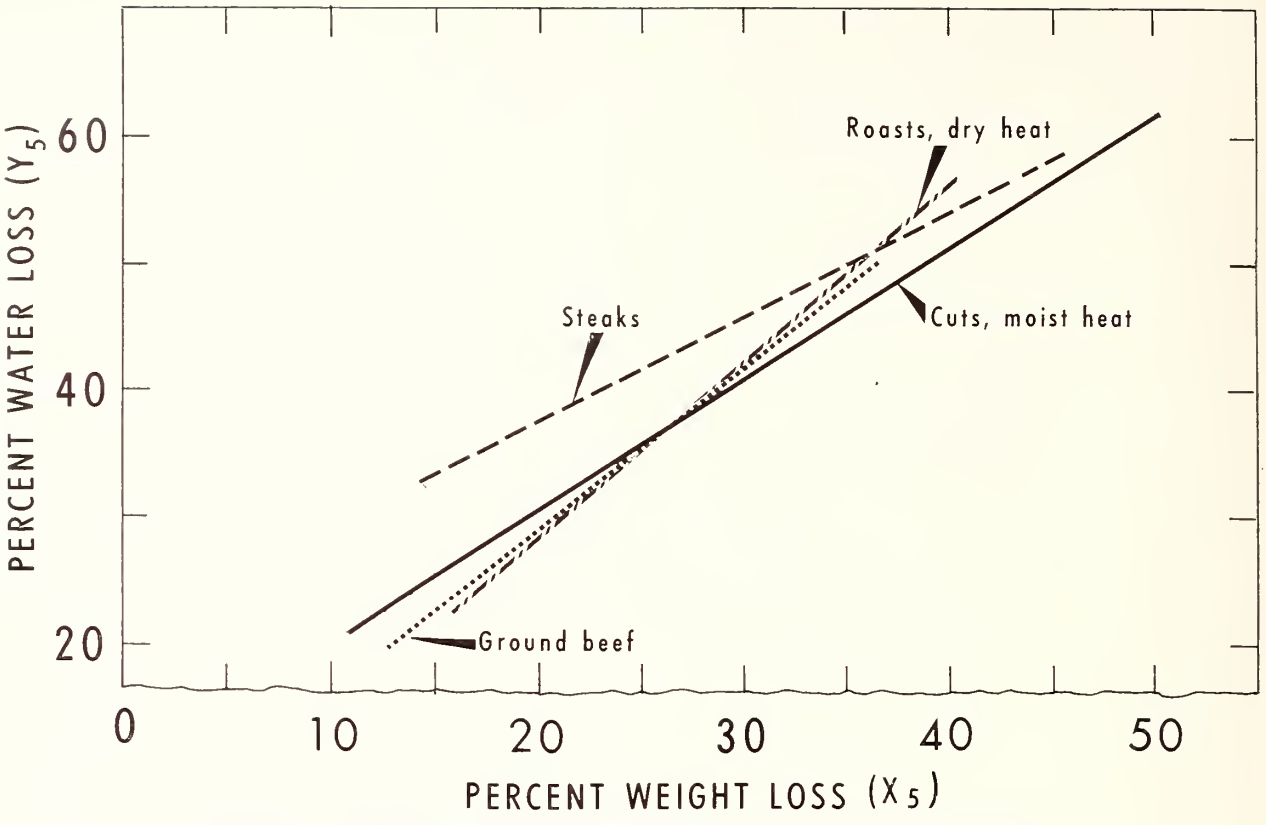

Figure 8.—Water loss and weight loss from raw to cooked meat.

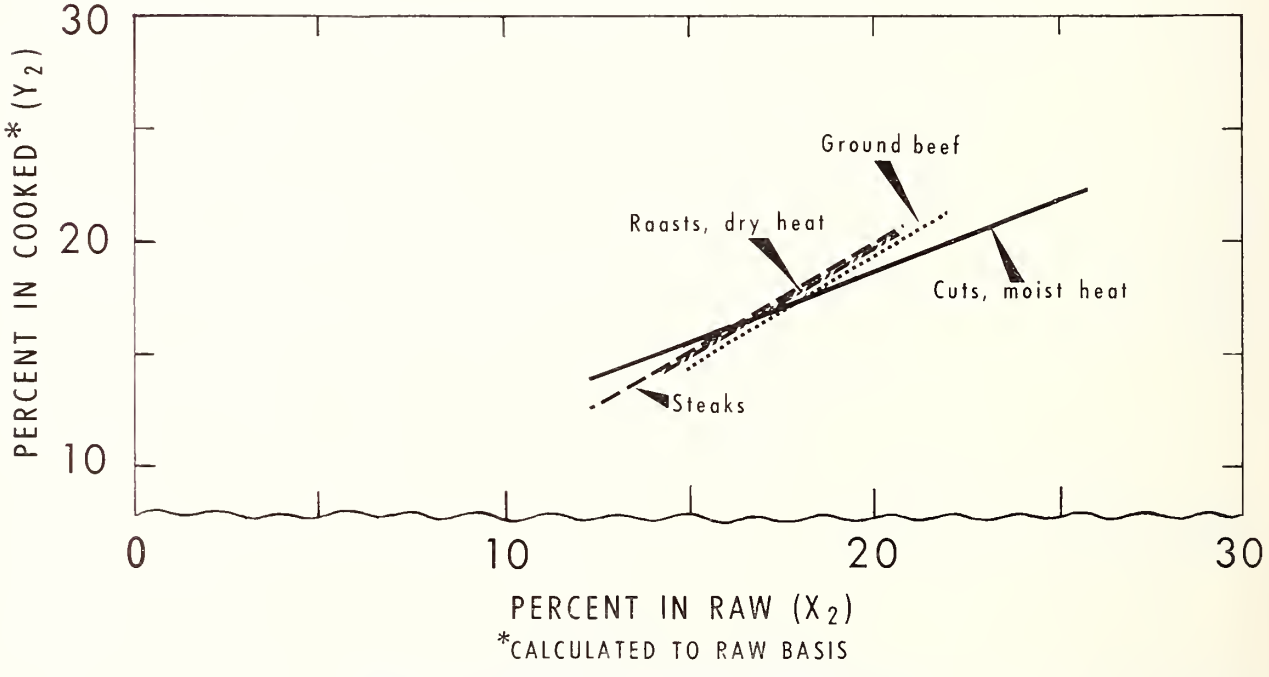

Figure 9.—Protein in raw and cooked meat.

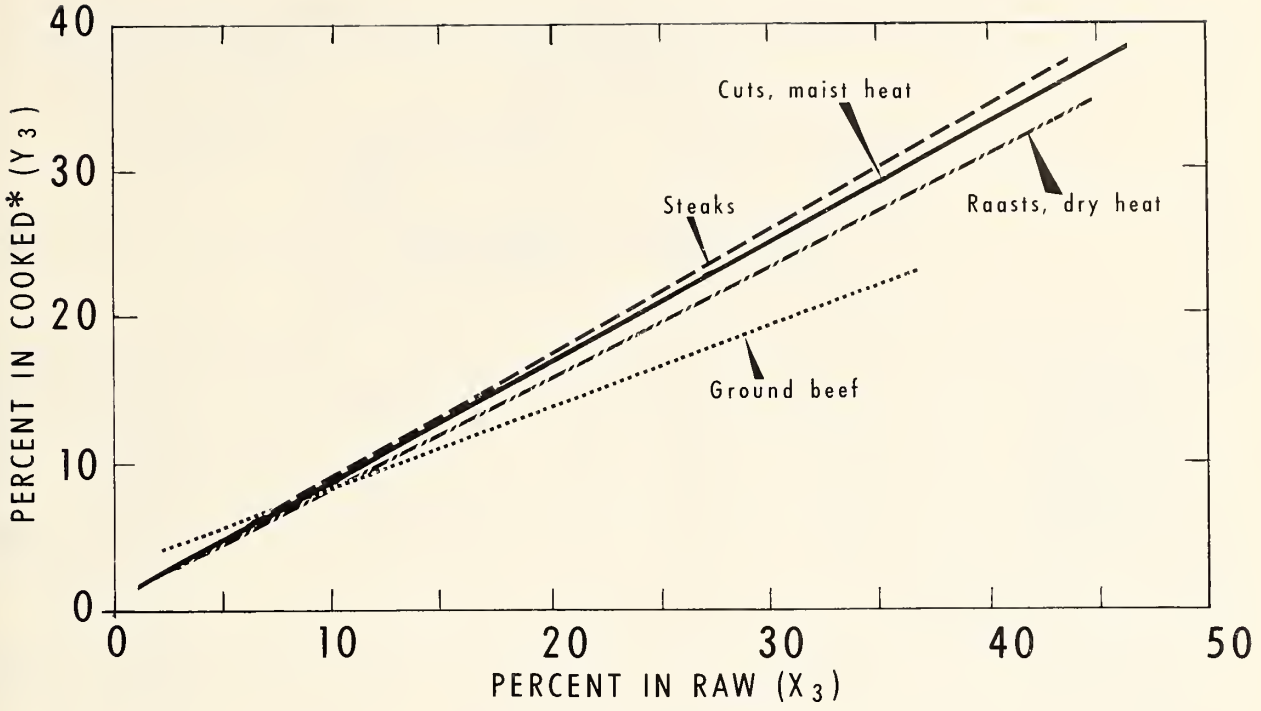

Figure 10.—Chemical fat in raw and cooked meat.

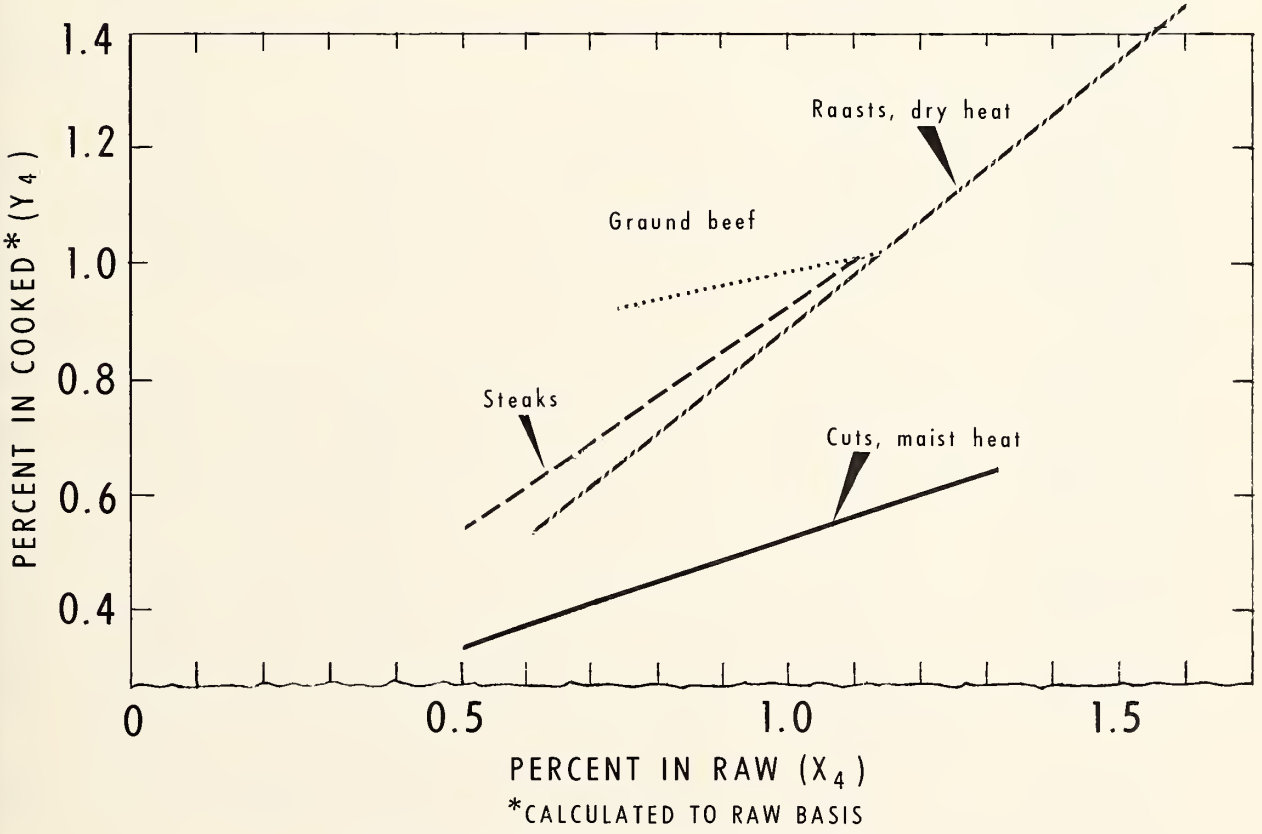

Figure 11.—Ash in raw and cooked meat.

TABLE 6.—*Physical and chemical composition of trimmed cuts and separable lean after cooking*

Description	Weight loss in cooking [1]	Physical composition					Chemical composition				
		Bone in [2]			Edible portion		Edible portion				
		Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water: By difference	Protein	Fat	Ash	Food energy
Brisket, cooked by moist heat:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./ 100 g.*
Choice grade:											
Total edible	33	53	24	23	69	31	41.7	22.9	34.8	0.6	412
Separable lean	33						59.1	29.7	10.5	.8	222
Good grade:											
Total edible	33	53	22	25	71	29	45.3	24.3	29.8	.7	373
Separable lean	33						61.1	30.3	7.7	.8	199
Standard grade:											
Total edible	33	53	21	26	72	28	47.3	25.1	26.9	.7	350
Separable lean	33						62.2	30.6	6.3	.8	187
Chuck cuts, cooked by moist heat:											
Entire chuck (1st–5th ribs, arm, and neck):											
Choice grade:											
Total edible	33	62	15	23	81	19	49.4	26.0	23.9	.7	327
Separable lean	33						59.7	30.0	9.5	.8	214
5th rib:											
Choice grade:											
Total edible	33	53	24	23	69	31	40.3	22.4	36.7	.6	427
Separable lean	33						56.5	28.9	13.9	.7	249
Good grade:											
Total edible	33	55	21	24	73	27	44.8	24.2	30.3	.7	377
Separable lean	33						59.2	29.8	10.2	.8	219
Standard grade:											
Total edible	33	56	15	28	78	22	50.1	26.2	23.0	.7	319
Separable lean	33						60.0	31.0	8.2	.8	206
3d–4th ribs:											
Choice grade:											
Total edible	33	59	21	21	74	26	43.7	23.8	31.9	.7	389
Separable lean	33						57.4	29.3	12.5	.8	238
Good grade:											
Total edible	33	59	19	22	76	24	47.4	25.2	26.7	.7	348
Separable lean	33						60.4	30.2	8.6	.8	207
Standard grade:											
Total edible	33	60	15	25	80	20	51.5	26.9	20.9	.7	303
Separable lean	33						61.7	30.5	7.0	.8	193
1st–2d ribs:											
Choice grade:											
Total edible	33	67	11	22	85	15	51.0	26.7	21.6	.7	309
Separable lean	33						58.6	29.6	10.9	.8	225
Good grade:											
Total edible	33	66	13	21	84	16	52.8	27.2	19.2	.7	289
Separable lean	33						60.9	30.2	8.1	.8	202
Standard grade:											
Total edible	33	67	9	23	88	12	57.0	28.9	13.4	.8	244
Separable lean	33						62.6	30.8	5.8	.8	184
Arm:											
Choice grade:											
Total edible	33	72	13	16	85	15	53.0	27.1	19.2	.7	289
Separable lean	33						61.7	30.5	7.0	.8	193
Good grade:											
Total edible	33	73	10	17	88	12	56.3	28.4	14.6	.7	253
Separable lean	33						63.1	30.9	5.2	.8	179
Standard grade:											
Total edible	33	74	8	18	90	10	58.7	29.2	11.3	.8	227
Separable lean	33						64.1	31.2	3.9	.8	168
Neck:											
Choice grade:											
Total edible	33	59	12	30	83	17	52.6	27.0	19.7	.7	293
Separable lean	33						61.5	30.4	7.3	.8	196

See footnotes at end of table.

TABLE 6.—*Physical and chemical composition of trimmed cuts and separable lean after cooking*—Continued

Description	Weight loss in cooking [1]	Physical composition					Chemical composition				
		Bone in [2]			Edible portion		Edible portion				
		Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water, By difference	Protein	Fat	Ash	Food energy
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./100 g.*
Chuck cuts, cooked by moist heat—Continued											
Neck—Continued											
Good grade:											
Total edible	33	58	12	30	83	17	53.6	27.6	18.1	0.7	281
Separable lean	33	------	------	------	------	------	62.6	30.8	5.8	.8	184
Standard grade:											
Total edible	33	55	11	34	83	17	55.4	28.2	15.7	.7	262
Separable lean	33	------	------	------	------	------	63.1	30.8	5.3	.8	179
Flank, cooked by moist heat:											
Separable lean:											
Choice grade	33	------	------	------	------	------	61.4	30.5	7.3	.8	196
Good grade	33	------	------	------	------	------	61.8	30.8	6.6	.8	191
Standard grade	33	------	------	------	------	------	62.7	31.0	5.4	.8	181
Foreshank, cooked by moist heat:											
Choice grade:											
Total edible	33	29	6	65	82	18	54.3	27.9	17.1	.7	273
Separable lean	33	------	------	------	------	------	62.6	30.8	5.8	.8	184
Good grade:											
Total edible	33	29	6	66	84	16	56.8	28.9	13.5	.7	245
Separable lean	33	------	------	------	------	------	63.4	31.0	4.8	.8	176
Standard grade:											
Total edible	33	27	5	69	84	16	57.7	29.3	12.2	.8	235
Separable lean	33	------	------	------	------	------	63.9	31.1	4.2	.8	171
Hindshank, cooked by moist heat:											
Choice grade:											
Total edible	33	13	7	80	66	34	46.1	25.1	28.1	.7	361
Separable lean	33	------	------	------	------	------	62.5	30.7	5.9	.8	184
Good grade:											
Total edible	33	12	5	83	70	30	51.0	27.2	21.1	.7	307
Separable lean	33	------	------	------	------	------	63.4	31.0	4.8	.8	176
Standard grade:											
Total edible	33	7	2	91	74	26	54.0	28.3	17.0	.7	274
Separable lean	33	------	------	------	------	------	64.1	31.2	3.9	.8	168
Loin [or short loin, cooked as steaks, broiled, braised, or sauteed:											
Porterhouse steak:											
Choice grade:											
Total edible	27	50	37	13	57	43	37.2	19.7	42.2	.9	465
Separable lean	27	------	------	------	------	------	57.9	30.2	10.5	1.4	224
Good grade:											
Total edible	27	50	37	13	58	42	38.9	20.5	39.7	1.0	446
Separable lean	27	------	------	------	------	------	60.3	31.1	7.1	1.4	197
Standard grade:											
Total edible	27	54	31	15	64	36	43.7	23.0	32.3	1.0	390
Separable lean	27	------	------	------	------	------	61.0	31.5	6.1	1.4	190
T-bone steak:											
Choice grade:											
Total edible	27	47	37	16	56	44	36.4	19.5	43.2	.9	473
Separable lean	27	------	------	------	------	------	57.9	30.4	10.3	1.4	223
Good grade:											
Total edible	27	49	35	16	58	42	39.2	20.6	39.2	1.0	442
Separable lean	27	------	------	------	------	------	60.2	31.1	7.3	1.4	199
Standard grade:											
Total edible	27	52	29	19	64	36	44.3	23.5	31.2	1.0	382
Separable lean	27	------	------	------	------	------	60.3	31.1	7.1	1.4	197

See footnotes at end of table.

TABLE 6.—*Physical and chemical composition of trimmed cuts and separable lean after cooking*—Continued

Description	Weight loss in cooking [1]	Physical composition					Chemical composition				
		Bone in [2]			Edible portion		Edible portion				
		Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water (By difference)	Protein	Fat	Ash	Food energy
Loin or short loin, cooked as steaks, broiled, braised, or sauteed—Continued											
Club steak:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./ 100 g.*
Choice grade:											
Total edible	27	45	33	22	58	42	37.9	20.6	40.6	0.9	454
Separable lean	27						56.0	29.6	13.0	1.4	244
Good grade:											
Total edible	27	48	27	24	64	36	42.8	22.9	33.3	1.0	398
Separable lean	27						58.5	30.5	9.6	1.4	217
Standard grade:											
Total edible	27	51	23	26	69	31	48.5	25.9	24.5	1.1	332
Separable lean	27						60.6	31.3	6.8	1.4	195
Loin end or sirloin, cooked as steaks, broiled, braised, or sauteed:											
Wedge and round-bone sirloin steak:											
Choice grade:											
Total edible	27	60	30	10	66	34	43.9	23.0	32.0	1.1	387
Separable lean	27						58.7	32.2	7.7	1.5	207
Good grade:											
Total edible	27	61	28	11	68	32	46.9	24.5	27.5	1.1	353
Separable lean	27						61.6	31.7	5.3	1.4	183
Standard grade:											
Total edible	27	63	24	13	72	28	50.3	26.4	22.1	1.2	312
Separable lean	27						62.2	31.9	4.5	1.4	177
Double-bone sirloin steak:											
Choice grade:											
Total edible	27	50	26	24	66	34	42.1	22.2	34.7	1.0	408
Separable lean	27						58.5	30.6	9.5	1.4	216
Good grade:											
Total edible	27	50	24	26	67	33	45.7	24.1	29.1	1.1	365
Separable lean	27						61.0	31.5	6.1	1.4	190
Standard grade:											
Total edible	27	52	21	27	72	28	50.3	26.2	22.4	1.1	314
Separable lean	27						62.4	31.9	4.3	1.4	175
Hipbone sirloin steak:											
Choice grade:											
Total edible	27	43	36	21	55	45	35.1	19.1	44.9	.9	487
Separable lean	27						56.3	29.8	12.5	1.4	240
Good grade:											
Total edible	27	45	33	22	58	42	39.0	21.0	39.0	1.0	441
Separable lean	27						59.2	30.8	8.6	1.4	209
Standard grade:											
Total edible	27	47	28	25	63	37	43.2	23.1	32.7	1.0	394
Separable lean	27						59.7	30.9	8.0	1.4	204
Short plate, cooked by moist heat:											
Choice grade:											
Total edible	33	48	35	16	58	42	36.0	20.6	42.8	.6	474
Separable lean	33						59.1	29.7	10.5	.8	222
Good grade:											
Total edible	33	50	31	19	61	39	39.9	22.3	37.3	.6	432
Separable lean	33						61.1	30.3	7.7	.8	199
Standard grade:											
Total edible	33	51	27	22	66	34	44.2	24.0	31.2	.6	384
Separable lean	33						62.4	30.6	6.2	.8	187
Rib, cooked as roasts, dry heat:											
Entire rib (6th–12th ribs):											
Choice grade:											
Total edible	27	57	32	11	64	36	40.0	19.9	39.4	.7	440
Separable lean	27						57.2	28.2	13.4	1.1	241

See footnotes at end of table.

TABLE 6.—*Physical and chemical composition of trimmed cuts and separable lean after cooking*—Continued

Description	Weight loss in cooking [1]	Physical composition					Chemical composition				
		Bone in [2]			Edible portion		Edible portion				
		Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water, By difference	Protein	Fat	Ash	Food energy
Rib, cooked as roast, dry heat—Continued											
11th–12th ribs:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./100 g.*
Choice grade:											
Total edible	27	49	39	12	55	45	36.3	18.3	44.7	0.7	481
Separable lean	27						57.3	28.2	13.3	1.1	240
Good grade:											
Total edible	27	54	32	14	63	37	41.9	20.9	36.3	.9	417
Separable lean	27						59.7	28.9	10.2	1.3	215
Standard grade:											
Total edible	27	60	24	16	71	29	47.6	23.6	27.8	1.0	352
Separable lean	27						60.6	29.2	8.9	1.3	205
9th–10th ribs:											
Choice grade:											
Total edible	27	54	36	10	60	40	38.1	19.2	42.0	.8	461
Separable lean	27						57.4	28.2	13.3	1.1	240
Good grade:											
Total edible	27	59	29	12	67	33	43.8	21.6	33.7	.9	396
Separable lean	27						59.9	28.9	10.0	1.3	214
Standard grade:											
Total edible	27	64	21	15	75	25	48.8	24.2	25.9	1.0	337
Separable lean	27						60.1	29.0	9.7	1.3	211
7th–8th ribs:											
Choice grade:											
Total edible	27	60	29	11	67	33	42.1	21.0	36.1	.8	415
Separable lean	27						57.7	28.3	12.9	1.1	237
Good grade:											
Total edible	27	62	25	13	72	28	46.2	22.9	29.9	1.0	367
Separable lean	27						60.0	29.0	9.8	1.3	212
Standard grade:											
Total edible	27	66	19	15	78	22	50.6	24.8	23.5	1.0	318
Separable lean	27						60.6	29.2	8.9	1.3	205
6th or blade rib, cooked by moist heat:											
Choice grade:											
Total edible	33	62	26	11	70	30	39.3	22.1	38.0	.6	437
Separable lean	33						55.1	28.5	15.7	.7	263
Good grade:											
Total edible	33	67	22	11	76	24	45.1	24.3	29.9	.7	373
Separable lean	33						58.6	29.6	10.9	.8	225
Standard grade:											
Total edible	33	71	16	13	82	18	50.2	26.1	23.0	.7	319
Separable lean	33						60.3	30.0	8.8	.8	207
Round:											
Entire round (round steak and heel of round), cooked as steaks, broiled, braised, and sauteed:											
Choice grade:											
Total edible	27	77	18	5	81	19	54.7	28.6	15.4	1.3	261
Separable lean	27						61.2	31.3	6.1	1.4	189
Round steak, cooked as steak, broiled, braised, and sauteed:											
Choice grade:											
Total edible	27	77	17	6	82	18	55.1	28.7	14.9	1.3	257
Separable lean	27						60.9	31.3	6.4	1.4	191
Good grade:											
Total edible	27	77	17	6	82	18	57.2	29.6	11.9	1.3	234
Separable lean	27						62.4	31.9	4.3	1.4	175

See footnotes at end of table.

TABLE 6.—*Physical and chemical composition of trimmed cuts and separable lean after cooking*—Concluded

Description	Weight loss in cooking [1]	Physical composition					Chemical composition				
		Bone in [2]			Edible portion		Edible portion				
		Separable lean	Separable fat	Bone	Separable lean	Separable fat	Water (By difference)	Protein	Fat	Ash	Food energy
Round—Continued											
Round steak, cooked as steak, broiled, braised, and sauteed—Con.	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Cal./ 100g.*
Standard grade:											
Total edible	27	79	14	7	85	15	60.1	30.8	7.8	1.4	202
Separable lean	27						63.4	32.2	3.0	1.4	165
Heel of round, cooked as roast, dry heat:											
Choice grade:											
Total edible	27	84	16	0	84	16	55.8	27.0	16.1	1.1	261
Separable lean	27						63.1	30.0	5.7	1.3	180
Good grade:											
Total edible	27	87	13	0	87	13	57.9	28.0	12.9	1.2	236
Separable lean	27						63.6	30.1	5.0	1.3	174
Standard grade:											
Total edible	27	92	8	0	92	8	61.6	29.3	7.9	1.2	196
Separable lean	27						64.7	30.4	3.6	1.3	162
Rump, cooked as roast, dry heat:											
Choice grade:											
Total edible	27	59	20	21	75	25	48.1	23.6	27.3	1.0	347
Separable lean	27						60.4	29.1	9.3	1.3	208
Good grade:											
Total edible	27	60	19	21	76	24	50.7	24.9	23.4	1.0	317
Separable lean	27						62.0	29.6	7.1	1.3	190
Standard grade:											
Total edible	27	60	16	24	79	21	53.4	26.0	19.5	1.1	287
Separable lean	27						63.1	30.0	5.7	1.3	180
Hamburger, ground beef; pan-broiled, oven-broiled, or sauteed:											
Regular ground	25						54.2	24.2	20.3	1.3	286
Lean ground	25						60.0	27.4	11.3	1.3	219

[1] Weight losses taken from USDA Agr. Handbk. 102, "Food Yields: Summarized by different stages of preparation" (*20*).
[2] Some cuts add to 100 ±1 percent because of rounding.

Physical Composition of Cooked Cuts

All samples used in the cooking loss analysis are boneless. For lack of adequate information, food composition tables have been based on the assumption that bone undergoes no change in weight during cooking. No studies are available in which the effect of cooking on bone in its normal position in meat has been determined with sufficient precision to determine this point. There are a few studies on cleaned bones cooked in water, and one in which rib bones were dissected and weighed before cooking, then tied in place and cooked with the meat. In the latter study, the bones lost 7.1 and 2.7 percent of their original weight, or 18 and 10 percent respectively of the total loss of weight. Losses on bones cooked alone, of course, run much higher. However, studies are needed on anatomically paired samples of meat cuts in which weights of bone can be determined before and after cooking. Such studies should explore the changes occurring in different kinds of cooking (e.g., moist and dry), and with bone embedded in meat (e.g., as in ham) and exposed (e.g., as in ribs or steaks). Until information of this kind is available, meat cooked with the bone will be calculated at too high a level of cooking losses, since in current practice all cooking losses are attributed to the edible portion.

In table 6, bone has been calculated from the data on trimmed cuts in table 4 on the assumption that bone undergoes no change in weight in cooking.

The distribution of lean and fat in the cooked cuts has been calculated as follows: Roasts cooked by dry heat—no change in distribution in cooking; steaks and chops, 0.9063×percent of lean in raw edible portion; cuts cooked by moist heat, 0.9857×percent lean. These factors are based on the results found in Technical Bulletin 1137 (*28*). After these values are calculated to the bone-in basis, the difference between 100 percent and lean plus bone is taken as separable fat.

Other Kinds of Meat

When this study was started, it was hoped that the same regression curves developed for beef could be used for all meats, regardless of kind. Very few data are available on which the method could be tested, but a few analyses of pork and lamb indicated that different curves would be required for them. However, there are not sufficient analyses available at this time to justify attempts to develop regression equations for pork and lamb. Also, no suitable analyses on veal are available.

Discussion

The method proposed shows great promise as a technique for estimating the composition of cooked meats. High correlations obtained, especially for protein and fat, suggest that a much greater degree of reliability in the composition of cooked meats may be obtained than in approaching the problem by merely averaging meats by cut or degree of doneness. The proposed method involves more calculations than do the other methods, but the greater reliability obtainable should justify its use to those concerned with estimating composition of cooked meats.

The analysis of relationships of raw to cooked meats would be greatly strengthened if a greater array of carefully paired samples were available for the study. The number of samples available is neither sufficiently large nor representative to show conclusively that this procedure is the final answer. With additional data it may develop that some of the variables that have been grouped together should be treated separately. For dry-heat roasts, for example, very few data were available on rare and well-done samples. It is possible that additional studies would indicate that different regression equations would give a better fit if the data were subdivided on the basis of doneness. Also, there is no assurance that the equations developed for ground lean beef are suitable for meat that is high in fat content. Studies on ordinary market samples of hamburger are greatly needed.

In fact, more samples for all kinds of meat and cooking methods are required to increase confidence in the results. But from the data available at this time, the procedure does appear to be at least a temporary answer to this problem.

CONCLUSION

The techniques described provide a method of calculating the composition of beef from the carcass basis, through the processes of cutting, trimming to the retail level, and cooking. The final values for cooked cuts bear a known relationship to the carcass from which they were prepared.

Since the relationship is to the fat in the carcass, the data for cuts may be easily recalculated any time evidence shows that a different fat content is more representative of the animals being marketed in a particular grade. Such adjustments would be indicated if there were significant changes in the standards for the grades, or if a larger quantity of data on carcass composition were available to weight the averages to higher or lower fat levels. It is possible, too, that marketing practices might change so as to shift the grade averages. A flexible procedure such as that described here is adaptable to many different conditions.

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[Some of the data used in this report are from unpublished material and are so noted]

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☆U.S. GOVERNMENT PRINTING OFFICE: 1965—780-107